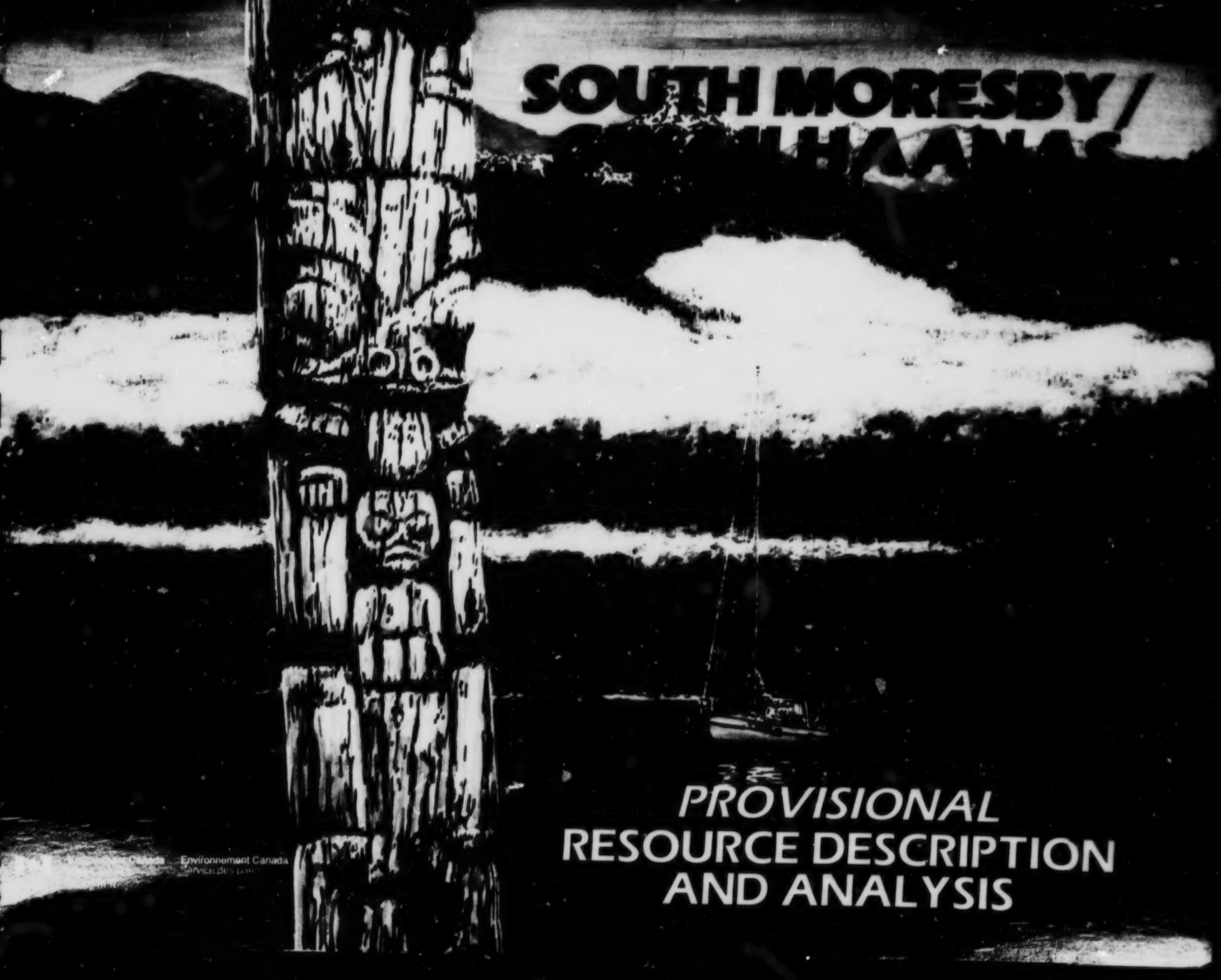

SOUTH MORESBY / [illegible] HAANAS

PROVISIONAL
RESOURCE DESCRIPTION AND ANALYSIS

Environnement Canada
Service des parcs

South Moresby/Gwaii Haanas National Park Reserve
British Columbia, Canada.

PROVISIONAL
RESOURCE DESCRIPTION & ANALYSIS

Canadian Parks Service
Western Region

1990

Prepared by Kurt Seel, John McIntosh and Rob Storeshaw

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ABSTRACT

This Resource Description and Analysis is an integral part of the Natural Resource Management Process of the Canadian Parks Service as approved for implementation by the Assistant Deputy Minister in 1979. It brings together all of the known available information about the Park Reserve and proposed Marine Park Reserve to form the basis for a comprehensive natural resource data base. It then analyzes this information and evaluates it in terms of the Canadian Parks Service mandate. In this way, the document provides both park managers and Canadians as a whole, with a reference digest of the known natural resources and the more pressing environmental concerns facing South Moresby/Gwaii Haanas National Park Reserve and the proposed South Moresby National Marine Park Reserve.

The data are presented as an integrated narrative which describes the natural resource components of the reserves and then evaluates those components in terms of management concerns and the status of knowledge. An evaluation of each resource described is then conducted, and broad resource capability and limitation statements are made, followed by an extrapolation of the scientific importance and interest of the resource. Management options and alternatives are then presented which are based on the foregoing information.

The above activities provide a platform from which a set of resource management objectives are derived. The objectives take into account any concerns previously identified and translate them into resource management requirements for South Moresby/Gwaii Haanas National Park Reserve and the proposed South Moresby/Gwaii Haanas National Marine Park Reserve.

ACKNOWLEDGEMENTS

The preparation of this document would not have been possible without the support of many of our colleagues, and to them we extend our deepest appreciation.

Dave Palmer, Regional Librarian, in particular deserves special acknowledgement for his long-standing and invaluable assistance.

K.E.S., J.D.M. & R.S.

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INTRODUCTION

The Natural Resource Management Process of the Canadian Parks Service, as described in Management Directive 2.4.6, prescribes a logical sequence of actions to plan for the management of natural resources in national parks and national park reserves.

As part of that process, the Resource Description & Analysis (R.D. & A.) serves the purpose of providing the primary natural resource information input into the Park Management Planning Process prescribed in Management Directive 4.2.1. In the case of the **South Moresby/Gwaii Haanas National Park Reserve,** because of the incomplete status of the information base and the time constraints imposed by the Memorandum of Agreement between the Government of Canada and the Government of the Province of British Columbia, only a **Preliminary Resource Description & Analysis** could be prepared at this time. Provisions have been made that will lead to the preparation of a more comprehensive R.D. & A. within the time span of three years. However, this situation does not in any manner alter the intent or objectives of this version of the R.D. & A., that is, in the context of the appropriate Management Directives.

In keeping with the Natural Resource Management Planning Process, the objectives of this **Resource Description & Analysis** are:

- *to provide planners and managers with a highly visual and consolidated description and analysis of the park reserve's natural resource base;*
- *to serve as an expansion of that aspect of the Interim Management Guidelines relating to the setting of objectives and the identification of resource management concerns;*
- *to familiarize Resource Conservation staff with the information available on the park reserve;*
- *to serve as a public information medium to assist in the presentation and subsequent understanding of the park reserve by the public.*

In the light of the foregoing statements, the description and analysis of the resource data is presented as a broad overview with an integrated evaluation to indicate the significance of the park reserve's natural resources at a level of generalization consistent with that of the original data. However, the level of detail presented varies depending on data availability, diversity, severity of environmental problems perceived, and other natural resource management problems related to human utilization of the reserve's natural resources.

This entire process does, wherever possible, reflect an ecological approach to resource management and has taken into consideration the role of the reserve within the national park system, as well as some of the constraints relating to park location, configuration, traditional use, the park agreement and the legal status of the park boundaries.

DATA SYNTHESIS

General Comments

All known resource inventory data judged to be relevant to the central purpose of this document were compiled during periods of concentrated literature searches. They were critically reviewed and then combined and composed into a connected whole of scientifically sound information, capable of describing the complex environmental character of the South Moresby/Gwaii Haanas Park Reserve.

The literature searches and subsequent reviews conducted, clearly identified inherent weaknesses and inconsistencies in the data base which are bound to affect the overall quality of the forthcoming resource description, the analysis, and the evaluation. They are as follows:

- Some information is out of date;

- Most of the resource data available at this time were not collected in a multi-disciplinary and integrated manner, but are usually thematic in character;

- Much of the thematic data are very site- and/or subject-specific, based on single observations which may not be temporally or spatially reliable, nor may their collection techniques be repeatable.

In spite of the foregoing comments, the available data base has yielded a considerable amount of environmental information previously not readily available to resource managers. Future research projects will serve to refine the data base and fill the knowledge gaps.

Synthesis & Integration

The literature review and annotated bibliography recently prepared by MacLaren Plansearch (Anon. 1989) for the South Moresby/Gwaii Haanas National Park Reserve have served as the focal point from which the "bringing together" of the available resource data commenced. Departmental libraries, electronic library services and data bases were consulted for additional resource information, as were several professional journals and other similar information sources. The resulting accumulation of printed information will require some time to be fully analyzed and evaluated, especially in light of the fact an ecological land classification project has yet to be initiated for the South Moresby/Gwaii Haanas National Park Reserve.

The resource data finally selected for the purpose of completing this Preliminary Resource Description & Analysis were integrated in a logical and sequential format as prescribed by the general guidelines of the **Natural Resource Management Process Manual** (1979), Chapter 5, Sections 5.4.1 to 5.4.6.

For a full listing of the information sources consulted, please refer to the **Bibliography**.

Select Reference Sources

Anonymous 1979.
Natural Resource Management Process Manual. Parks Canada, Natural Resource Conservation Division, Ottawa, Ontario; Sect. 5.0.

________ 1989.
South Moresby National Parks Biophysical Literature Review and Annotated Bibliography. MacLaren Plansearch; Vancouver, British Columbia. Vol. I: Literature Review, 121p., appx.; Vol.II: Annotated Bibliography, tbls.

RESOURCE DESCRIPTION & ANALYSIS

General Methodology

Because this document is the main input from the Natural Resource Management Process to the **Park Management Planning Process**, it must reflect the Parks Canada Policy and the overall direction adopted by the national system for resource conservation, protection, and management. Therefore:

The **Resource Description & Analysis** . . .

- *must represent a broad overview, integration, and evaluation for significance of natural resource data at a level of generalization which reflects the complexity of the park reserve's ecosystems and which is consistent with that of the original data;*

- *will show where the levels of detail will vary depending on data availability, diversity, complexity and severity of the environmental concerns, and natural resource management issues related to the past, present and expected human utilization of the park reserve's natural resource base;*

- *will take into consideration the park objectives, role within the national park system and any constraints relating to park location, size, traditional use, or the park reserve agreement;*

- *will reflect the temporal and financial constraints imposed by management;*

- *will wherever possible utilize an ecological or integrated approach;*

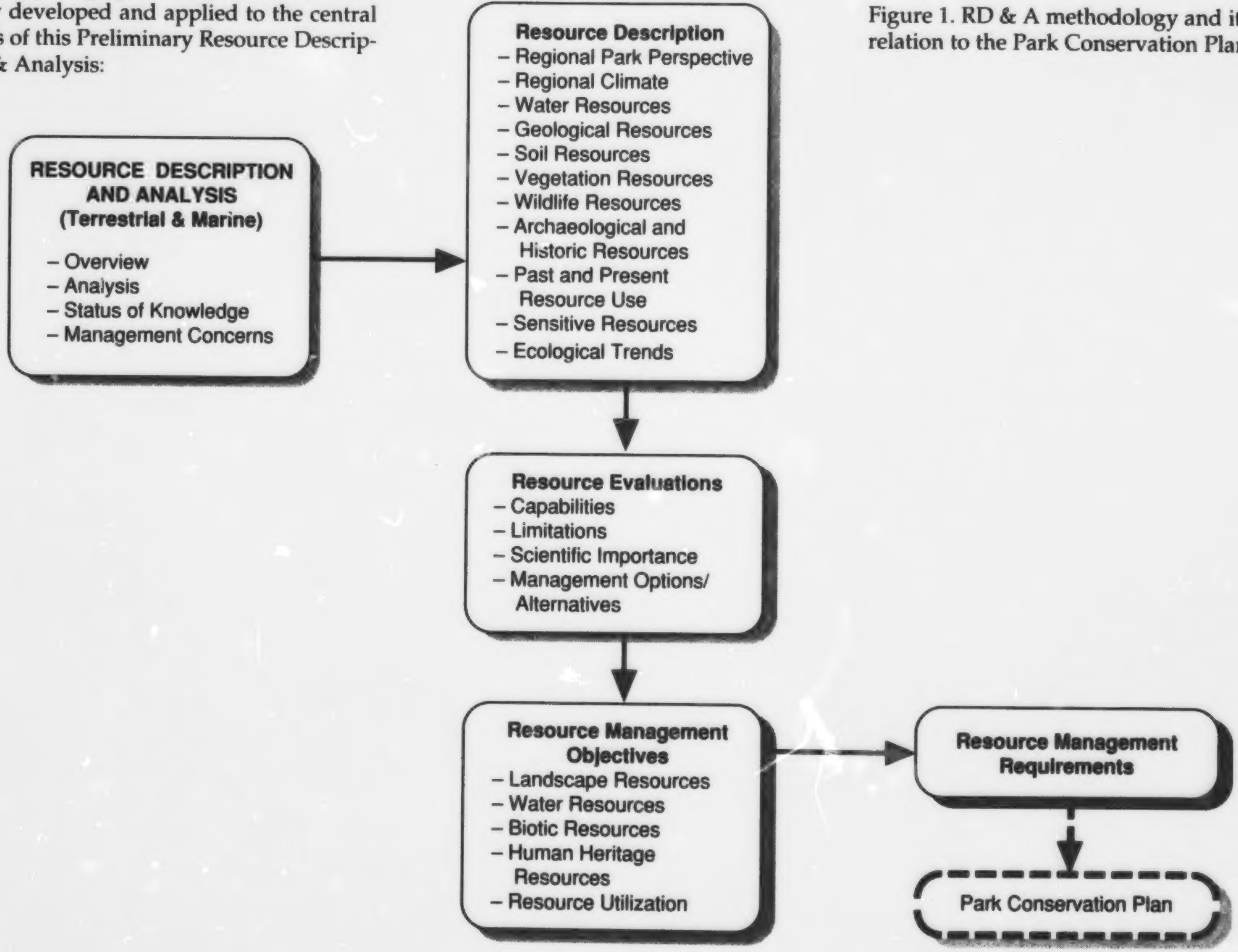
- *will allow for future updating of the methodology, product format, and the information data base;*

- *will reflect the need to identify and priorize resource management issues and problems;*

- *will take into account the projected audience.*

It is also necessary to the understanding of the methodology as a whole that a clear outline be presented of the treatment and flow of the natural resource information throughout the various parts of this Preliminary Resource Description & Analysis.

Following is a graphic outline of the methodology developed and applied to the central tenets of this Preliminary Resource Description & Analysis:


RESOURCE DESCRIPTION AND ANALYSIS (Terrestrial & Marine)
– Overview
– Analysis
– Status of Knowledge
– Management Concerns
Resource Description
– Regional Park Perspective
– Regional Climate
– Water Resources
– Geological Resources
– Soil Resources
– Vegetation Resources
– Wildlife Resources
– Archaeological and Historic Resources
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Resource Evaluations
– Capabilities
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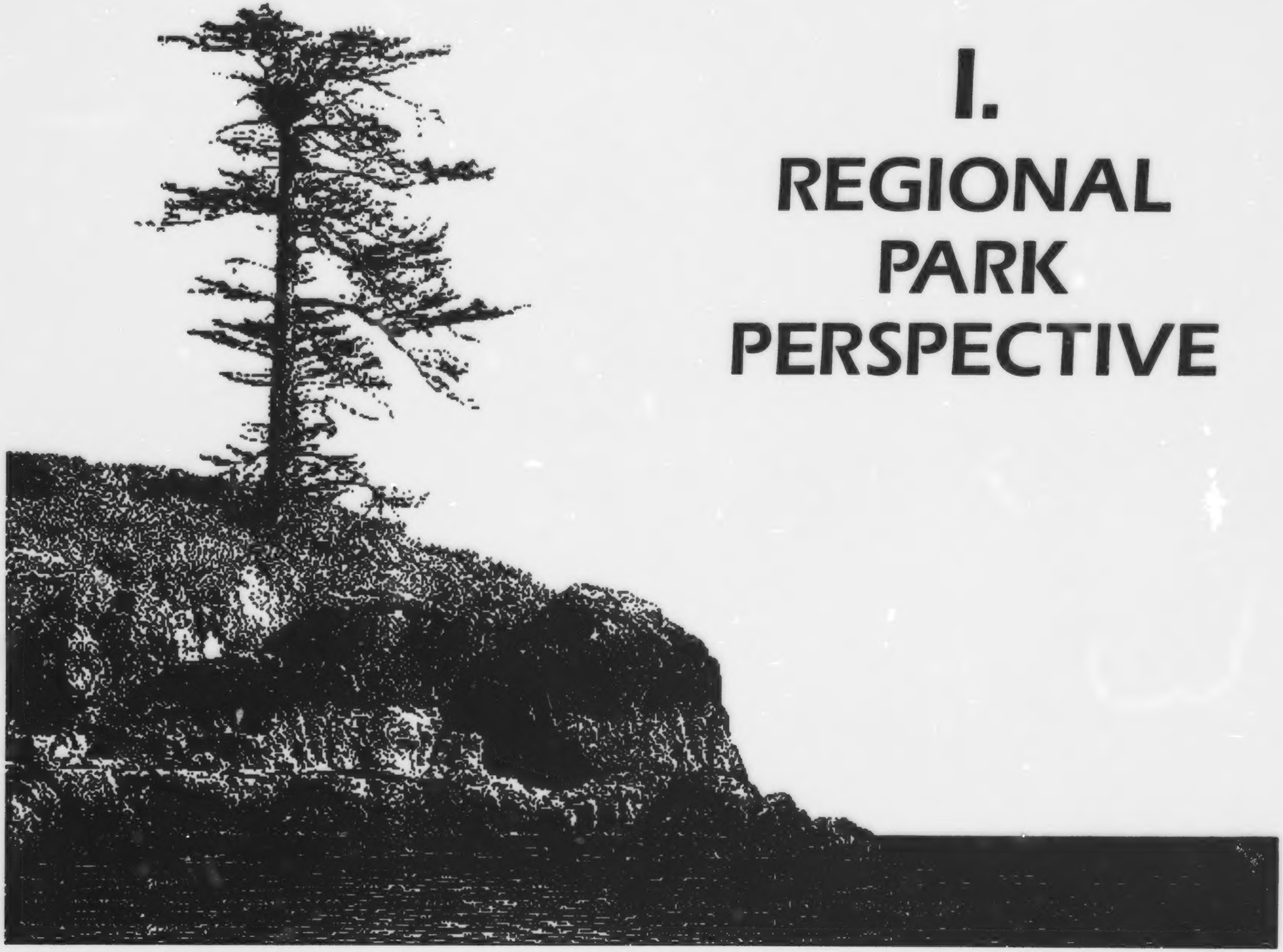
– Scientific Importance
– Management Options/ Alternatives
Resource Management Objectives
– Landscape Resources
– Water Resources
– Biotic Resources
– Human Heritage Resources
– Resource Utilization
Resource Management Requirements
Park Conservation Plan

Figure 1. RD & A methodology and its relation to the Park Conservation Plan.

I.
REGIONAL PARK PERSPECTIVE



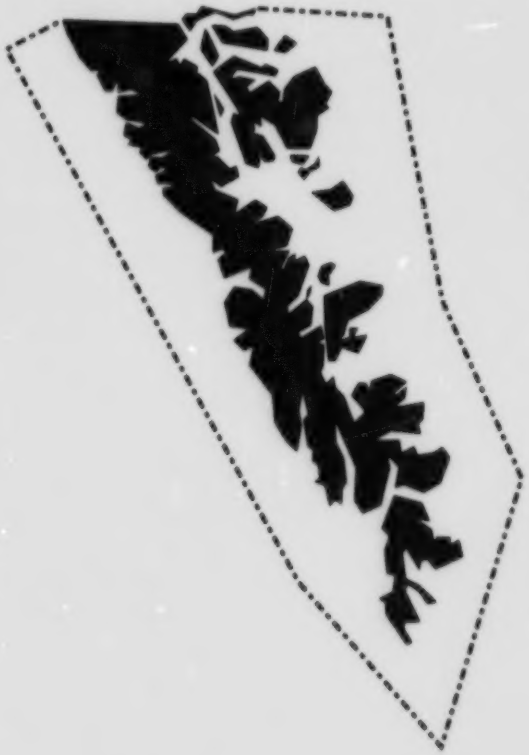
REGIONAL PARK PERSPECTIVE

General Overview

On July 12th, 1988, the Government of Canada and the Government of the Province of British Columbia signed a "Memorandum of Agreement" that established the **South Moresby/Gwaii Haanas National Park Reserve** on the Queen Charlotte Islands.

The federal-provincial agreement was signed by Department of Fisheries & Oceans Minister Tom Siddon on behalf of Department of Environment Minister Tom McMillan, and by the British Columbia Parks Minister Terry Huberts. The terrestrial portion of the national park reserve will cover some 1,470 square kilometres of land in the southern part of the Queen Charlotte Islands, while the proposed boundaries of the marine park reserve will encompass 3,394 square kilometres of the adjacent marine waters of the Pacific Ocean and Hecate Strait. The final boundaries for the national marine park reserve will be determined jointly by Canada and British Columbia in 1993.

The agreement commits Canada to an expenditure of $106 million, which will pay the costs of park development and operation, and includes a $50 million Queen Charlotte Islands Regional Economic Development Initiative for projects outside of the park reserve. British Columbia will contribute the land for the reserve and up to $20 million.



The interim purpose statement for the newly established South Moresby/Gwaii Haanas National Park Reserve makes it clear that it will protect for all time:

- three natural areas of significance; *i.e.* the Pacific Coast Mountain Terrestrial Natural Region, the Hecate Strait and West Queen Charlotte Islands and the Marine Natural Regions;
- plants, animals, fish and insects important to science for study of adaptation and evolution;
- the heartland of Haida culture;
- an outstanding wilderness and cultural heritage area where public understanding, appreciation and enjoyment are encouraged in a manner that leaves it unimpaired for this and future generations.

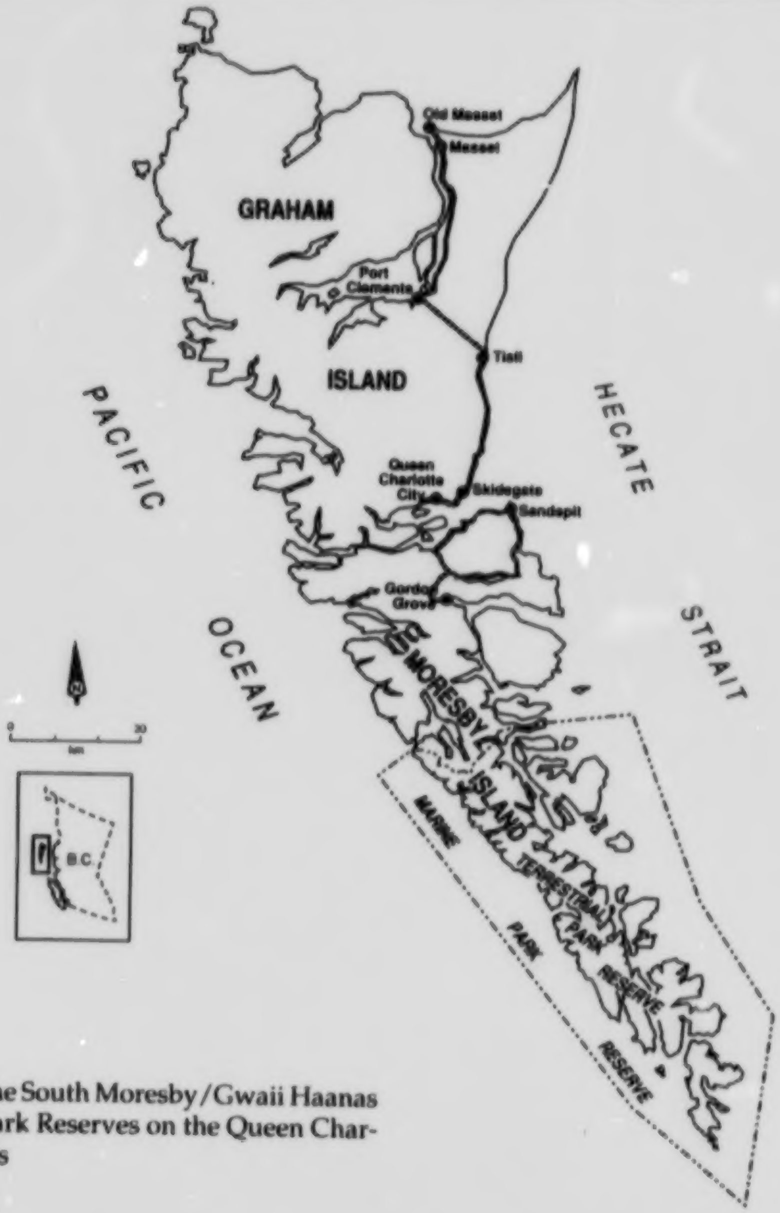

Old Masset
Masset
GRAHAM
ISLAND
Port Clements
Tlell
Queen Charlotte City
Skidegate
Sandspit
Gordon Grove
PACIFIC
OCEAN
HECATE
STRAIT
MORESBY
ISLAND
MARINE
PARK
RESERVE
TERRESTRIAL
PARK
RESERVE
N
0
30
km
B.C.

Figure 2. The South Moresby/Gwaii Haanas National Park Reserves on the Queen Charlotte Islands

The park reserve is a wilderness archipelago of 138 islands, of which Moresby Island is the largest, that extend for about 90 kilometres from north to south. It comprises the southern 15 percent of the Queen Charlotte Islands which are located between 130 and 132 degrees W Longitude and 52 and 54 degrees N Latitude, about 120 to 240 kilometres west of the coast of mainland British Columbia, and 640 kilometres north of the City of Vancouver. Its topography is highly variable and lies entirely within the Queen Charlotte Ranges physiographic region, where peaks rise to over 900 metres in elevation, while near-shore depths off its west coast drop to over 3000 metres (Grzybowski & Slocombe 1988). There are over 1,600 kilometres of shoreline within the park reserve area.

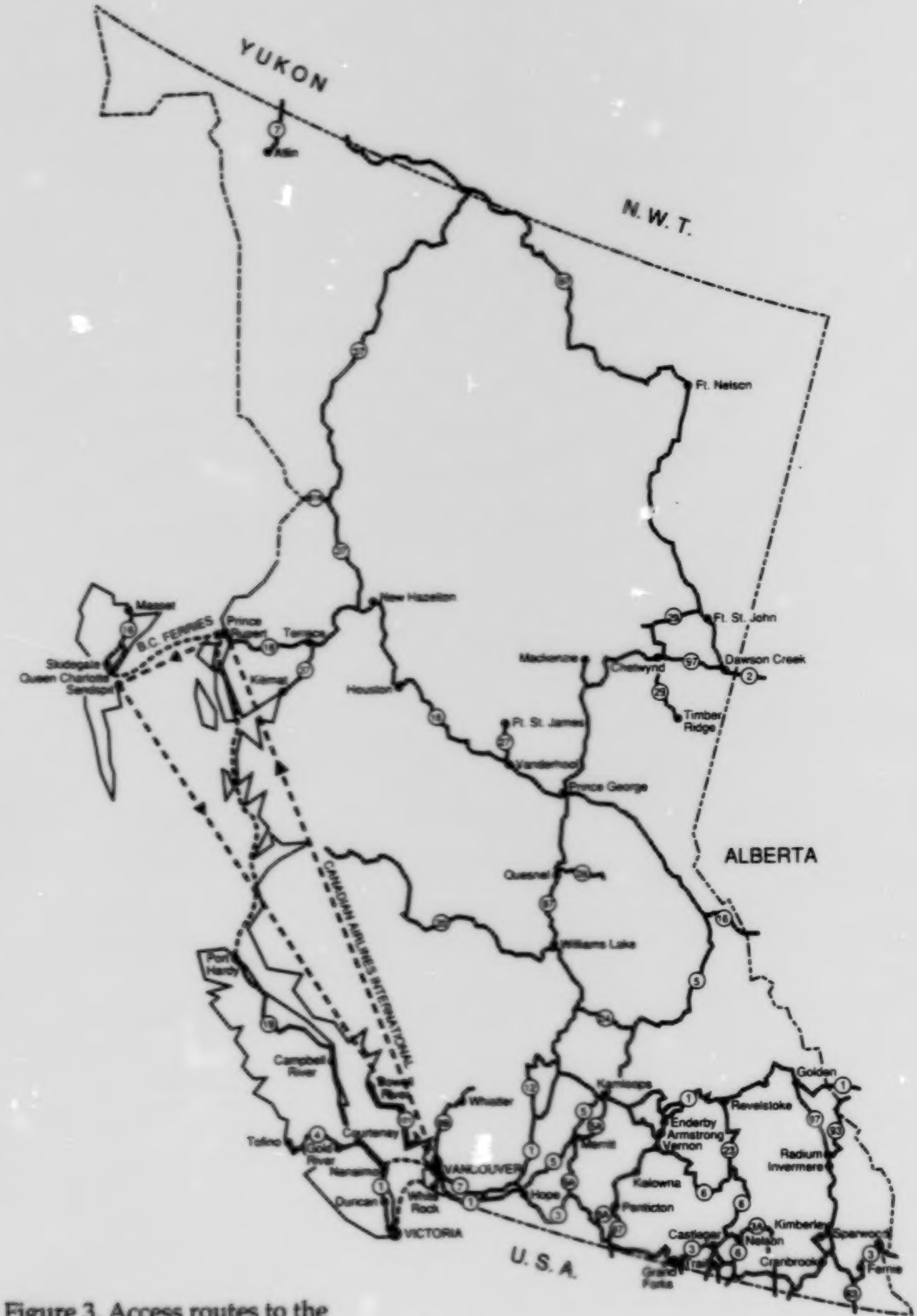

YUKON
N.W.T.
ALBERTA
U.S.A.
Atlin
Ft. Nelson
Ft. St. John
Dawson Creek
Chetwynd
Mackenzie
Timber Ridge
New Hazelton
Masset
B.C. FERRIES
Prince Rupert
Terrace
Skidegate
Queen Charlotte
Sandspit
Kitimat
Houston
Ft. St. James
Vanderhoof
Prince George
Quesnel
Williams Lake
CANADIAN AIRLINES INTERNATIONAL
Port Hardy
Campbell River
Powell River
Whistler
Kamloops
Revelstoke
Golden
Enderby
Armstrong
Vernon
Radium
Invermere
Merritt
Tofino
Gold River
Courtenay
Nanaimo
VANCOUVER
Kelowna
Hope
White Rock
Duncan
Penticton
VICTORIA
Castlegar
Nelson
Kimberley
Cranbrook
Sparwood
Fernie
Grand Forks
Trail

Figure 3. Access routes to the Queen Charlotte Islands

Access to the park reserve is essentially by charter of a floatplane, helicopter, or boat. There are currently no roads, stores, motels, or other visitor services facilities within the reserve. The nearest "jumping-off" point for the more self-contained and adventurous of park visitors is Gordon Cove near Moresby Camp on Cumshewa Inlet, which can be reached via logging roads from Sandspit, but which is still about 30 air kilometres from the northern park reserve boundary.

Most visitors to the Queen Charlotte Islands arrive either by commercial aircraft, provincial ferry service, or private craft. Other visitors arrive in the park reserve and adjacent areas through the boat and air services provided by locally-, nationally-, and internationally-organized tours and charters. Canadian Airlines International provides daily jet service to Sandspit from Vancouver via Prince Rupert. Trans-Provincial Airways provide additional flight services to the Islands from Prince Rupert. The British Columbia Ferry Service provides passenger and vehicle access to Queen Charlotte City (Skidegate) from Prince Rupert and Port Hardy.

The small communities of Sandspit, Queen Charlotte City, Port Clements and Masset provide a range of visitor facilities and services such as hotels, motels, campgrounds, restaurants, stores with marine and camping supplies, service stations, and visitor information services operated either by the British Columbia Ministry of Tourism or the Northwest Tourist Association.

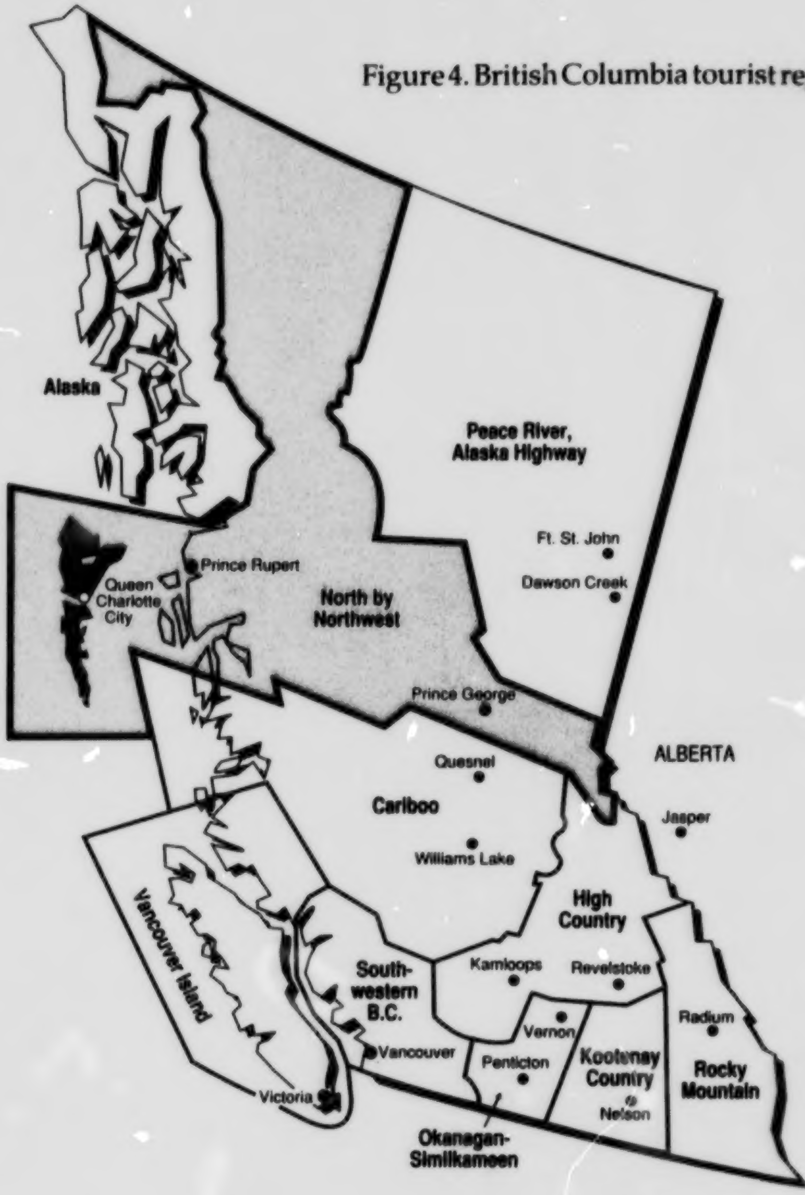
The "North by Northwest Tourist Region" of British Columbia (Anon. 1988c), of which the Queen Charlotte Islands are a part, is said to have undergone a 14 percent growth in tourism during the period from 1985 to 1986. More specifically however, and because of strong specialty tourism markets, tourist travel to and within the Queen Charlotte Islands has been undergoing a strong and remarkable growth during the past few years. By contrast, other northern tourism areas apparently underwent a notable percentage decrease in visitations, due to Expo '86 being staged in Vancouver. Based on local tourism operators' perspectives, as reported upon by MacLaren Plansearch (Anon. 1988d), the total number of visits grew by 21 percent between 1985 and 1986, and because of advance bookings for 1987 a growth of 28 percent was anticipated (Anon. 1987a). The same researchers stated revenue growth to have reached 30 percent between 1985 and 1986.

Three distinct types of tourists have been noted to visit the Islands:

- hotel and motel users, who may or may not utilize the opportunities offered by commercial tour boat operators or companies;
- lodge users that may arrive as part of a package tour;
- campers and recreation vehicle users.

International tour groups, helicopter tours, charter boat tours, canoe and kayak recreationists known to visit the South Moresby National Park Reserve do not appear to be of sufficiently large numbers to rate a specific mention in MacLaren's report (Anon. 1987a). Yet some of the operators interviewed repeatedly mentioned specific visitation locations like Hotsprings Island, Windy Bay, Juan Perez Sound, Ninstints and other Haida cultural sites. They did, however, report that 41 percent of the operators interviewed felt that the presence of a national park on South Moresby Island would improve their business. Of the remaining operators, about 30 percent felt a national park would not increase their business, while 7 percent stated it would actually decrease tourist visits to the Islands.

Figure 4. British Columbia tourist regions


Alaska
Peace River,
Alaska Highway
Ft. St. John
Dawson Creek
Prince Rupert
Queen Charlotte City
North by Northwest
Prince George
ALBERTA
Quesnel
Cariboo
Jasper
Williams Lake
High Country
Vancouver Island
Kamloops
Revelstoke
South-western B.C.
Vernon
Radium
Vancouver
Penticton
Kootenay Country
Rocky Mountain
Nelson
Victoria
Okanagan-Similkameen

PROJECTED GROWTH IN TOURISM & REVENUES, 1987 - 1992
for the Queen Charlotte Islands

	1987	1988	1989	1990	1991	1992
Number of Visitors:	16,000	19,200	23,040	27,648	31,795	36,564
Revenue (in millions):	6.4	7.6	9.1	10.9	12.5	14.3

One further point of importance is that the visitor profile for the Queen Charlotte Islands presents a close parallel to the rapidly growing wilderness adventure market that attracts wealthier and older clientele than is the norm for the overall travelling public within British Columbia. More than one-third of the visitors were found to be over 55 years of age, and more than three-quarters (77 percent) were older than 35 years of age. Only about 20 percent of the travellers surveyed were under 34 years of age. Demographically, these travellers are significantly different from the stereotype of low budget hikers or kayakers visiting the Islands (Anon. 1987a). Perhaps as a direct parallel to this, suggestions have been made to develop first class lodges at Hotsprings Island, Sandspit and Rose Harbour.

In terms of projected growth in tourism and revenues within the Queen Charlotte Islands, the following figures taken from MacLaren Plansearch (Anon. 1987a), provide some interesting speculations based on the assumption that annual growth rates of 20 percent in 1985-1990 and 15 percent in 1991-1992 will occur.

The relative importance of other, but topic-related tourist travel data (Anon. 1976; Anon. 1980; Anon. 1981; Anon. 1986b; Anon. 1988b; Anon. 1988c) are much more difficult to analyze, because of the Queen Charlotte Islands having been "attached" to the North by Northwest Tourism Region. That region consists primarily of the mainland area extending roughly from the B.C.-Alberta provincial boundary near Jasper, to Cassiar and Prince Rupert. The tourist travel data that might have been attributable to the Islands have thus been included in the region's total statistics, and are unfortunately indistinguishable from them.

In summary, it has been predicted (Anon. 1987a):

- tourism growth will in fact take place in several market segments on the Islands;

- the travel industry and potential tourists have a definite interest in the area and that the South Moresby/Gwaii Haanas National Park Reserve will draw worldwide attention to itself and the Islands in general.

A. THE NATURAL TERRESTRIAL REGIONS OF CANADA

The earliest contribution to the formal description of the physiography of British Columbia were made by G.M. Dawson in the 1890 Transactions of the Royal Society of Canada, and R.A. Daly in the 1912 Memoir No. 38 of the Geological Survey of Canada, a national service of which both gentlemen were well-known members. Subsequent contributions were made by other members of the same service; *i.e.* L. Reinecke in 1915, H.S. Bostock in 1948, and S.S. Holland of the British Columbia Department of Mines and Petroleum Resources in 1964.

The natural regions of Canada, as we know them today, are based on the physiographic regions of the country that were established by members of the Geological Survey of Canada, as well as other physical scientists. H.S. Bostock formalized the physiographic regions of Canada in 1967, and they were first published in map form by Bostock (1970).

The Systems Planning Division of the Canadian Parks Service adopted Bostock's physiographic region concept in 1971. To meet the requirements of park planning both in the terrestrial and marine sense, the planners enriched that concept with ecological, geographical and geological considerations, and thus developed the definition for "natural regions", as expressed in the National Parks System Planning Manual:

> **they are natural landscapes and/or environments of Canada which may be separated from other such landscapes and environments by surface feature which are readily observable, discernible and understandable by the layman as well as by scientists and others more familiar with the natural features of Canada.**
>
> **(Anon. 1974)**

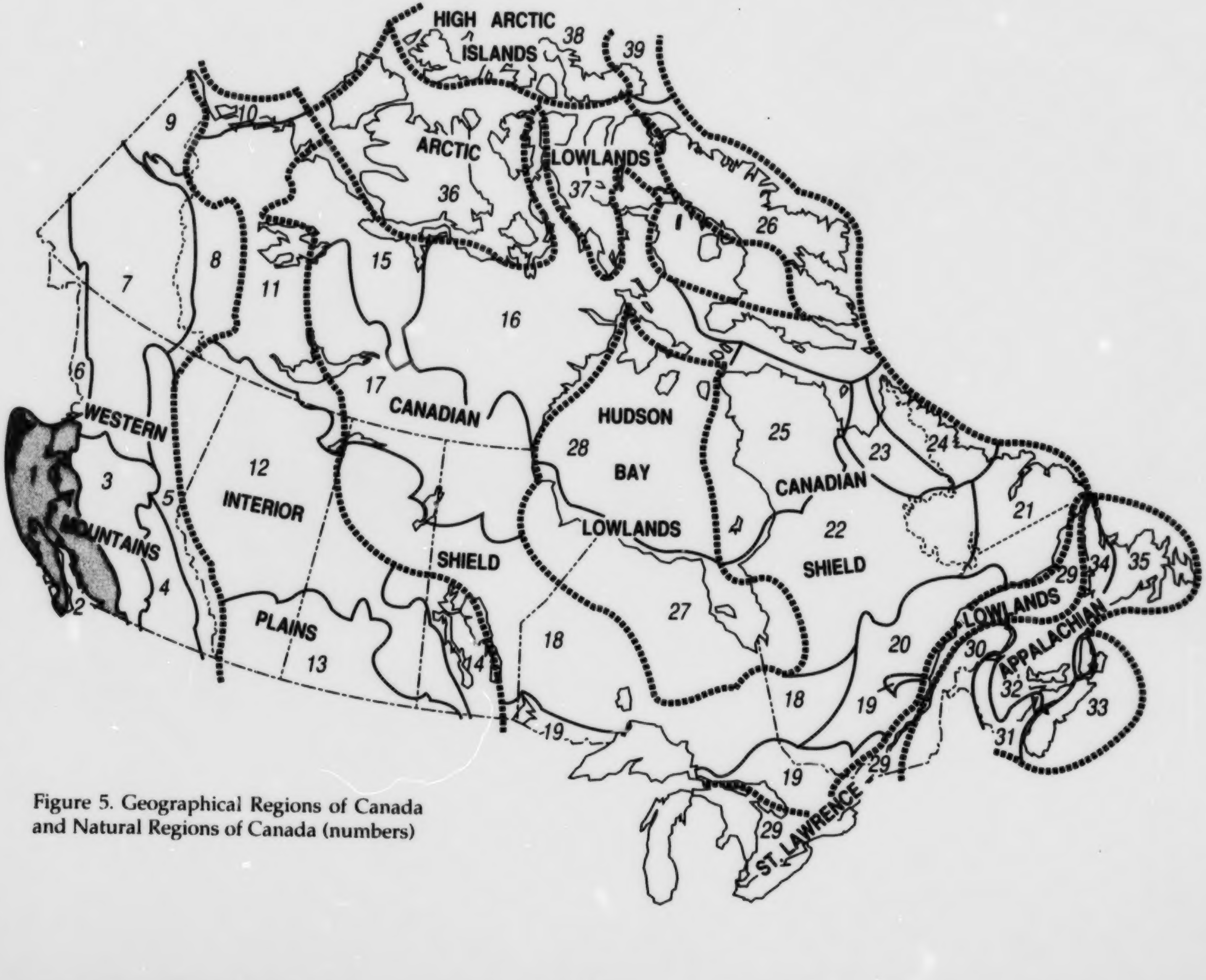

HIGH ARCTIC ISLANDS
38
39
9
10
ARCTIC
36
LOWLANDS
37
26
8
7
11
15
16
6
17
CANADIAN
WESTERN
HUDSON
BAY
28
25
23
24
12
INTERIOR
3
5
MOUNTAINS
CANADIAN
21
22
LOWLANDS
SHIELD
SHIELD
4
2
34
35
29
PLAINS
LOWLANDS
13
14
18
27
APPALACHIAN
20
30
32
33
18
19
19
31
29
19
29
ST. LAWRENCE

Figure 5. Geographical Regions of Canada and Natural Regions of Canada (numbers)

The application of the natural region concept to the Canadian land mass has resulted in there being recognized 39 terrestrial natural regions and 9 marine natural regions within Canada. While several representative examples of the natural regions find themselves protected in one or more national parks or national park reserves, others are not yet represented within the system of national parks. The South Moresby/Gwaii Haanas National Park Reserve is the second representative example of the natural region it is situated in.

With the foregoing information as the background, the terrestrial portion of **South Moresby/Gwaii Haanas National Park Reserve** is an integral part of *Natural Region 1* which is otherwise referred to as the *Pacific West Coast Mountain Natural Region* of Canada. This natural region is subdivided into three major physiographic divisions:

- the Insular Mountains of the Outer Mountain Area;
- the Hecate and Nahwitti Lowlands, also known as the Hecate Depression of the Coastal Trough;
- and the Pacific-, Kitimat-, Hazelton- and Cascade Mountains of the Coast Mountain Area.

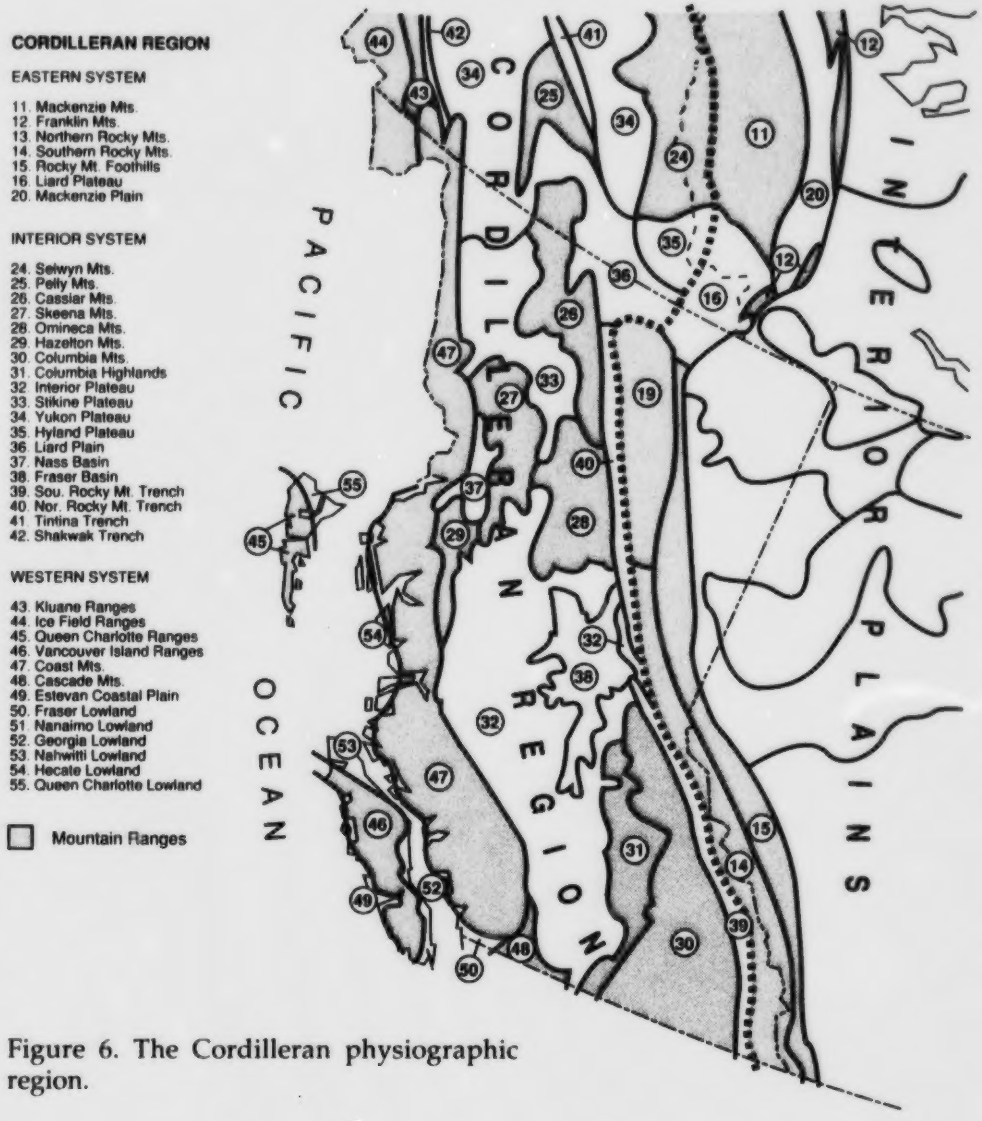

CORDILLERAN REGION
EASTERN SYSTEM
11. Mackenzie Mts.
12. Franklin Mts.
13. Northern Rocky Mts.
14. Southern Rocky Mts.
15. Rocky Mt. Foothills
16. Liard Plateau
20. Mackenzie Plain
INTERIOR SYSTEM
24. Selwyn Mts.
25. Pelly Mts.
26. Cassiar Mts.
27. Skeena Mts.
28. Omineca Mts.
29. Hazelton Mts.
30. Columbia Mts.
31. Columbia Highlands
32. Interior Plateau
33. Stikine Plateau
34. Yukon Plateau
35. Hyland Plateau
36. Liard Plain
37. Nass Basin
38. Fraser Basin
39. Sou. Rocky Mt. Trench
40. Nor. Rocky Mt. Trench
41. Tintina Trench
42. Shakwak Trench
WESTERN SYSTEM
43. Kluane Ranges
44. Ice Field Ranges
45. Queen Charlotte Ranges
46. Vancouver Island Ranges
47. Coast Mts.
48. Cascade Mts.
49. Estevan Coastal Plain
50. Fraser Lowland
51. Nanaimo Lowland
52. Georgia Lowland
53. Nahwitti Lowland
54. Hecate Lowland
55. Queen Charlotte Lowland
Mountain Ranges
PACIFIC OCEAN
CORDILLERAN REGION
INTERIOR PLAINS

Figure 6. The Cordilleran physiographic region.

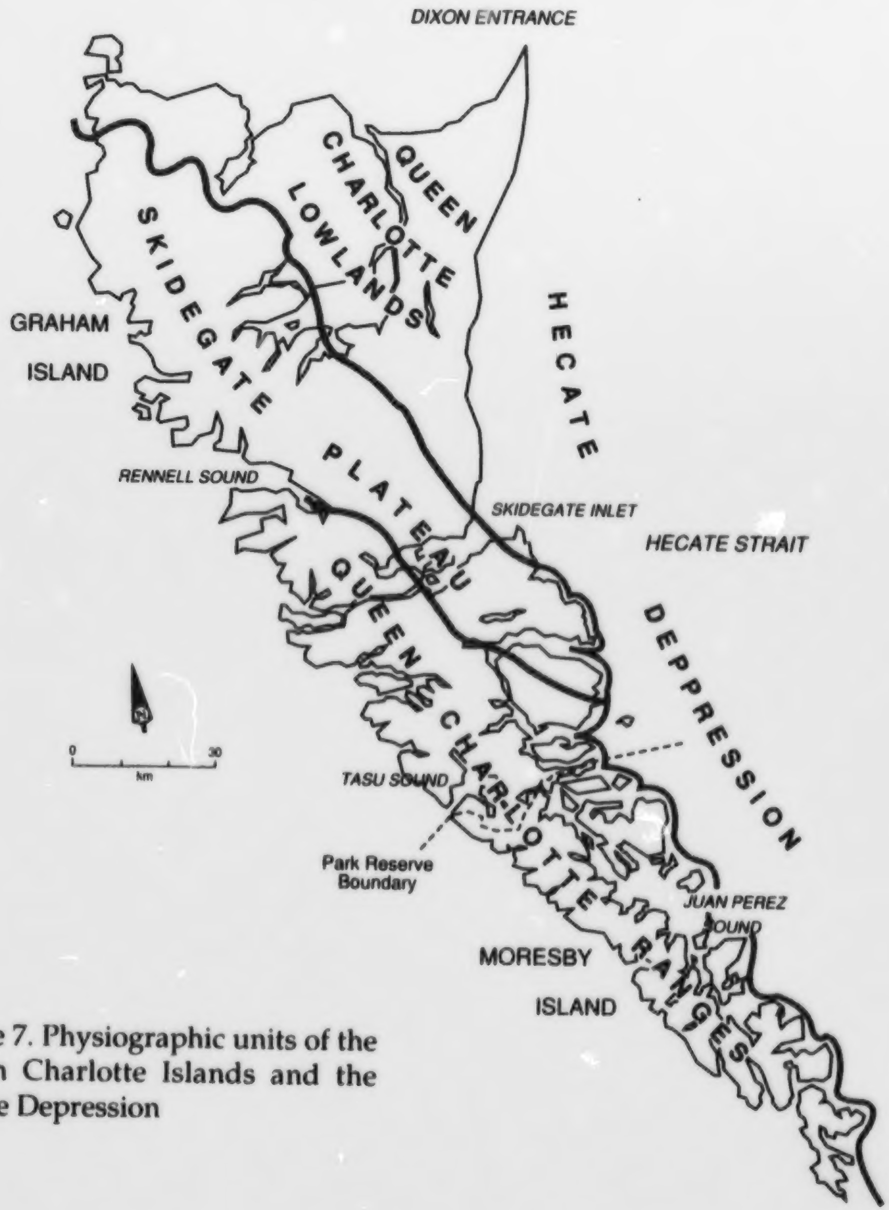

DIXON ENTRANCE
QUEEN CHARLOTTE LOWLANDS
SKIDEGATE PLATEAU
HECATE
GRAHAM ISLAND
RENNELL SOUND
SKIDEGATE INLET
HECATE STRAIT
DEPRESSION
QUEEN CHARLOTTE RANGES
0
30
km
TASU SOUND
Park Reserve Boundary
JUAN PEREZ SOUND
MORESBY ISLAND

Figure 7. Physiographic units of the Queen Charlotte Islands and the Hecate Depression

While the geologic characters of the major physiographic divisions are quite different from one another, they have evolved under similar regional conditions of tectonic activity along the continental margin. The Queen Charlotte Islands themselves have been subdivided into three distinct physiographic units that are bordered on the west by the Pacific Ocean and on the east by the Hecate Strait (Hecate Depression). They are the Queen Charlotte Lowlands, the Skidegate Plateau, and the Queen Charlotte Ranges.

More specifically, the South Moresby/ Gwaii Haanas National Park Reserve occupies the southern half of the Queen Charlotte Ranges of the Outer Mountain Area, as part of the Western System of the Cordilleran Region (Anon. 1973; Anon. 1974; Anon. 1975; Bostock 1970).

The Queen Charlotte Ranges are a northwesterly trending chain of mountains with a pronounced ruggedness in their northern half, while their southern reaches tend to be lower and gentler in topographic expression. The highest peaks are Mount Needham, Mount Kermode and Mount de la Touche which are all about 1200 metres in elevation. Their principal physiographic character is their ruggedness, particularly along the outer coast where the land mass of the Islands joins a major submarine escarpment associated with the Queen Charlotte Fault. The Skidegate Plateau consists of Tertiary rock with bevelled and dissected erosional surfaces. By contrast, the Queen Charlotte Lowlands are a part of the Hecate Depression, show

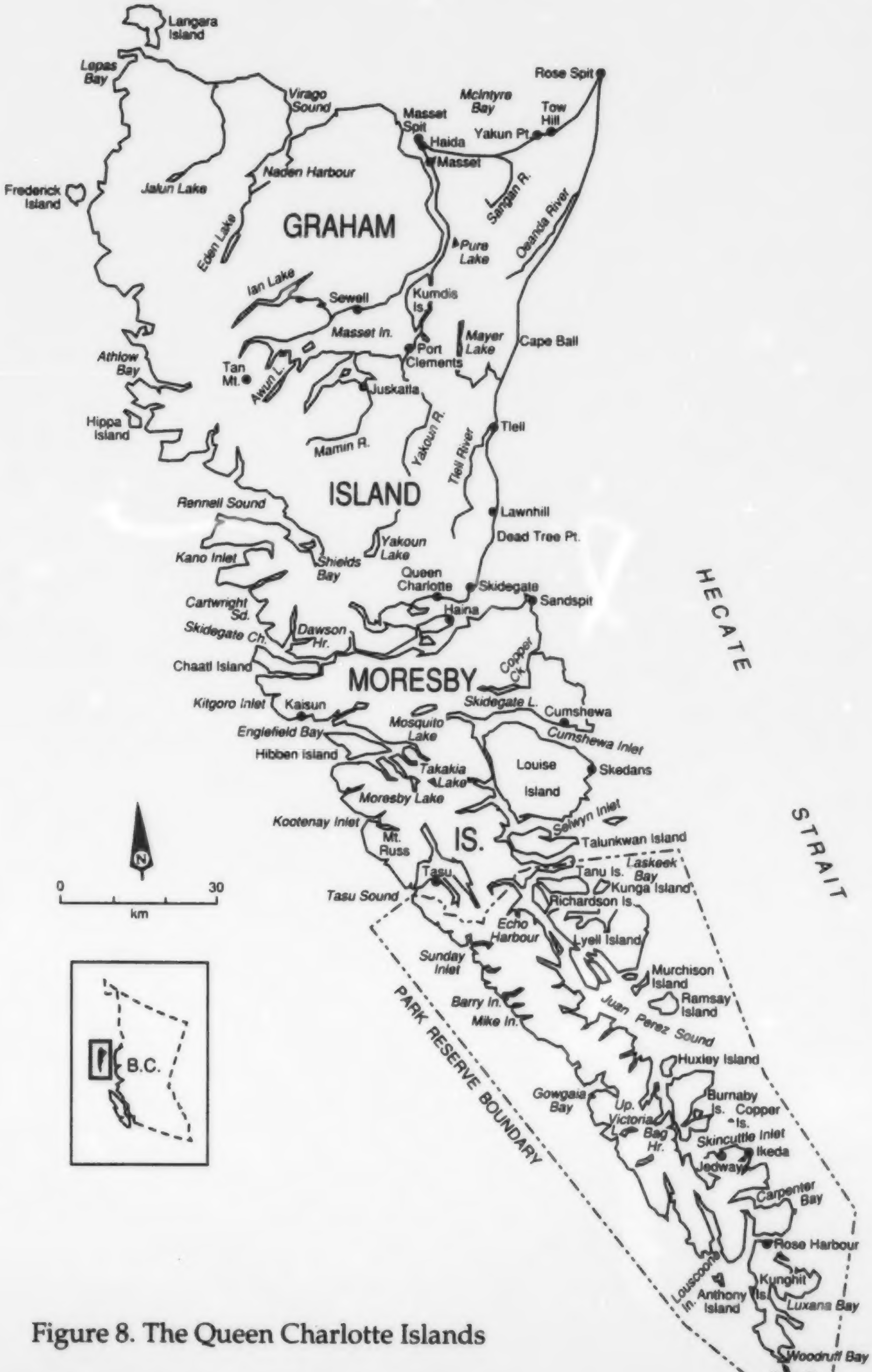

Langara Island
Lepas Bay
Virago Sound
Rose Spit
McIntyre Bay
Tow Hill
Masset Spit
Haida
Yakun Pt.
Masset
Naden Harbour
Frederick Island
Jalun Lake
Sangan R.
Oeanda River
GRAHAM
Eden Lake
Pure Lake
Ian Lake
Sewell
Kumdis Is.
Masset In.
Mayer Lake
Cape Ball
Port Clements
Athlow Bay
Tan Mt.
Awun L.
Juskatla
Hippa Island
Tlell
Mamin R.
Yakoun R.
Tlell River
ISLAND
Lawnhill
Rennell Sound
Dead Tree Pt.
Yakoun Lake
Kano Inlet
Shields Bay
Queen Charlotte
Skidegate
Sandspit
HECATE
Cartwright Sd.
Haina
Skidegate Ch.
Dawson Hr.
Copper Ck.
Chaatl Island
MORESBY
Kitgoro Inlet
Kaisun
Skidegate L.
Cumshewa
Englefield Bay
Mosquito Lake
Cumshewa Inlet
Hibben Island
Louise Island
Skedans
Takakia Lake
Moresby Lake
Selwyn Inlet
STRAIT
Kootenay Inlet
Mt. Russ
IS.
Talunkwan Island
Laskeek Bay
Tanu Is.
Kunga Island
Tasu
0
30
km
N
Tasu Sound
Richardson Is.
Echo Harbour
Lyell Island
Sunday Inlet
Murchison Island
Ramsay Island
Barry In.
Mike In.
Juan Perez Sound
PARK RESERVE BOUNDARY
B.C.
Huxley Island
Burnaby Is.
Copper Is.
Gowgaia Bay
Up. Victoria
Bag Hr.
Skincuttle Inlet
Ikeda
Jedway
Carpenter Bay
Rose Harbour
Louscoone In.
Anthony Island
Kunghit Is.
Luxana Bay
Woodruff Bay
Cape St. James

Figure 8. The Queen Charlotte Islands

little relief, and consist primarily of outwash plain materials overlying sandstones of Tertiary age that show no evidence of having been glaciated. Glaciations have been a major erosive agent in the past and have left their mark in the form of cirques, U-shaped valleys, and fjords on the land. However, the fjords are much smaller and less well developed than those on the mainland. There are a few short, and poorly developed river systems, and even fewer lakes. One hotspring is known to occur on Hotsprings Island within the national park reserve (Anon. 1975).

Graham Island and the northern parts of Moresby Island are settled, while the national park reserve area is home to but a handful of permanent residents. Resource exploitation has been and is, in all but the reserve area, the primary income producing activity. Logging, mining, fishing, hydrocarbon development, marine and land transportation industries, among other commercial activities, are the largest employers on the Queen Charlotte Islands (Anon. 1975). More recently, the tourist industry is beginning to attract developers.

Geoconsult Ltd. (Anon. 1975), deemed the Queen Charlotte Mountains Area subdivision of Natural Region 1 to represent a unique combination of themes:

> **Foremost is its unshielded position before the Pacific Ocean. This interface represents a high energy zone which may be largely unmatched anywhere in Canada. Ocean processes have served to carve out their own mark in Region 1 in the area primarily on the west coast. This is represented by sea caves, stacks, terraces and sea walls of striking development. High energy erosion combined with folded and faulted Mesozoic volcanic rock headlands and deeply excavated fiords further qualify this area as unique. The mountain chain itself is reminiscent of the linear pattern of the Mesozoic island arc system that they largely represent.**

They elaborated further about the area's attributes by drawing attention to the hotsprings found on one of the national park reserve's islands, the luxuriant rainforest, peatlands , endangered species of animals, and the threats posed by offshore oil exploration and transportation (Anon. 1975). In a separate study, Foster & Pojar (1977), reached the same conclusions about the natural history of the Queen Charlotte Islands.

In terms of South Moresby/Gwaii Haanas National Park Reserve's status as an area of national importance, Foster & Pojar (1977) provided a glowing report and an extensive and comparative assessment listing of the natural attributes of the area. Geoconsult Ltd. (Anon. 1975) on the other hand made the terse statement following:

> **The Queen Charlotte Mountains area is in a class of its own since the west coast presents a vivid display of oceanic processes at the land-water interface. This in combination with the rugged mountain landscape rich in geologic and physiographic history theme representation and laced with beautiful fiords on both coasts provides an area that has no rival in Canada. Coastal forest is basically the only land ecosystem representation, although the rain forest development is exceptional. Unique mammals occur in the area and the major breeding locality for sea lions occurs in the islands of the southern tip of the area.**

They added the cautionary comment however, that in order to conduct a thorough comparison of the potential areas of national importance within Natural Region 1, a much more extensive information base than was available at the time of their assessment must be compiled first.

THEMES	PACIFIC RANGES	KITIMAT RANGES	HAZEL-TON MT.	CASCADE MTS.	VAN. IS. RANGES	Q.C. MTS.	HECATE LOW.	ESTEVAN CST. PLN.	NAHWITTI LOW.	Q.C. LOW.
LANDFORMS										
Wave cut terrace						⬬	⬬	⬬	●	⬬
Peneplain	●	●		●	•	●	⬬		•	●
High & rugged mtn.	⬬	●	●	●	●					
Low & rugged mtn.	●	●	●	⬬	●	⬬	●	•	•	
Rounded mtn.	•	⬬		●	●	●			•	
Monadnock mtn.	•			⬬				•		
Volcanic mtn.	●	•					●			●
Cirques, Aretes	⬬	⬬	●	•	•	●	⬬			
U-shaped valley	⬬	⬬	⬬	●	●	•	•		•	
Hanging valley	⬬	●	•	•	•		●			
Drumlins etc.	•	•	•		•	•	•			●
Fjords	⬬	⬬			●	•	●	•	•	
Sea caves, cliffs	⬬				•	⬬	•	●	●	●
Archipelago	•	•			●	●	⬬	●	•	
Deltas	●	•			●		⬬	•	●	
Rugged, high beach	⬬	⬬				⬬			•	
Low, irregular beach	●	●			⬬	●	●	⬬	⬬	
Sand beach					•	•	•	⬬	●	⬬
Wind swept Isles						⬬	●	●	⬬	
Hot springs	⬬	•			•	•	•	●		
Cirque glacier	⬬	●	●	•	●					
Valley glacier	⬬	●								
Icefield	⬬									
Solution Caves					⬬			•		
GEOLOGICAL HISTORY										
Continental drift	•	•			⬬	⬬		●		●
Faults, fracture joints	⬬	⬬	●	•	●	⬬	⬬	⬬	●	●
Metamorphism	●	●			⬬	•	●	●		
Cenozoic Era	●	⬬	●	●	⬬	⬬	⬬	⬬	●	⬬
Mesozoic Era	⬬	⬬	●	●	⬬	⬬	●	●	●	
Paleozoic Era				●	•	•		•		
LAND ECOSYSTEM										
Subalpine	●	●	●	●	•		•			
Montane	⬬	●	•	●						
Coast	•				⬬	⬬	⬬		⬬	⬬
Columbia				•						
Tundra	⬬	●								

NOTE: ⬬ well represented or unique ● good representation • poor representation

Figure 9. Qualitative graphic comparison of the rating of major themes in physiographic subdivisions of Natural Region 1 (after Anon. 1975).

RESOURCE COMPONENT	PACIFIC RANGE	KITIMAT RANGE	HAZEL-TON MTS.	CASCADE MTS.	VAN. IS. RANGE	QUEEN CHAR. MTS.	HECATE LOW-LAND	ESTEVAN COASTAL	NAHWITTI LOW-LAND	QUEEN CHAR. LOW.
BIRDS										
Peregrine Falcon		●			●	●	●	●	●	
Bald Eagle	●	●			●	●	●	●	●	●
Sandhill Crane (breeding range)							●	●	●	
Trumpeter Swan	●	●			●	●	●	●	●	●
MAMMALS										
Vancouver Is. Marmot					●					
Wolf	●	●	●	●	●		●	●		
Grizzly	●	●	●	●			●			
Amer. Martin	●	●	●	●	●	●	●	●	●	●
Fisher	●	●	●	●			●			
Wolverine	●	●	●	●	●		●	●	●	
Caribou	●	●	●							

● indicates presence only

Figure 10. Distribution of endangered species in Natural Region 1. (after Anon. 1975)

a) RESOURCE ANALYSIS

Even though the South Moresby/Gwaii Haanas National Park Reserve is now recognized as a legally acquired component of the still expanding national park system , much more time will have to be invested in study and reflection before its conservation-, economic-, and socio-cultural values to the region it is situated in and the nation as a whole, can be fully understood and appreciated. The full range of human emotions from euphoria to resignation and even objection associated with the recent inception of the national park reserve, still appear to impose themselves upon objective analyses of the natural resources present there. An interval of a few years is required before a full rationalization of most or all aspects of the natural resources involved and the sociopolitical factors at work can be discussed in a detached manner.

Much of the way Canadians will perceive the role of the national park reserve within the "North by Northwest" tourist region, will depend on the manner and time period in which the various clauses of the "Memorandum of Agreement" between Canada and the Province of British Columbia, and the land claim settlement with the Haida, are brought to fruition.

- Management Concerns

Current management concerns are closely aligned with the points made foregoing, as well as with the fulfilment of the yet to be fully expressed expectations perceived by locals, mainlanders, tourists and politicians. The issues of providing the appropriate levels of protection and preservation of all natural and cultural heritage resources, while allowing for their use, enjoyment and associated developments, will yet have to be addressed fully.

The most pressing concern therefore is to develop the knowledge required and the capability to understand and predict how future development of the region will impact upon the role the park reserve must play within the national park system of this nation. The bringing about of a beneficial resolution of this concern will have to include the mutual cooperation with and between the park management team and the land managers of adjacent jurisdictions and municipalities. It is anticipated that the new parks policy (in preparation) and the yet to be prepared park management plan for the South Moresby/Gwaii Haanas National Park Reserve will both serve to foster better understanding and cooperation between the Canadian Parks Service, other jurisdictional administrations in the region, and the people of the Haida.

- Status of Knowledge

For the purposes of this document, the available regional tourism information and the discussions of the natural region in which the Queen Charlotte Islands are situated, are barely adequate. This statement applies both to the appropriateness of the former information base, and the age of the studies concerning the natural region and the related areas of national significance (NACS). It is expected that the intensive and extensive literature reviews required for the final completion of this Resource Description & Analysis by 1992, will go a long way to alleviate the stated situation.

b) SELECT REFERENCE SOURCES

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Physiographic Subdivisions of Canada. Geological Survey of Canada, Physiographic Regions of Canada, Map No. 1254A, Ottawa, Ontario; Scale 1:5,000,000.

Foster, J.B. & J. Pojar 1977.
Natural History Theme Study of a Natural Area of Canadian Significance on the Queen Charlotte Islands, British Columbia (Natural Region #1). Prepared for Parks Canada in Accordance with Contract 76-209 129p., figs., tbls., maps.

Holland, J.S. 1974.
Landforms of British Columbia: A Physiographic Outline. B.C. Dept. of Mines & Petroleum Resources, Bulletin No. 48, Victoria, British Columbia 138p., map.

B. NATURAL MARINE REGIONS OF CANADA

Following on the earlier work of G.M.Dawson, R.A. Daly, L. Reinecke and H.S. Bostock, S.S. Holland outlined what we now recognize as the physiographic subdivisions in British Columbia (Holland 1976). Those subdivisions include the continental land mass out to the Continental Shelf. Dixon Entrance, Hecate Strait, and Queen Charlotte Sound, the three major coastal water bodies surrounding the Queen Charlotte Islands, all overlie the Hecate Depression of the Coastal Trough. The Pacific Ocean itself overlays the Continental Shelf as it touches the western shores of the Queen Charlottes.

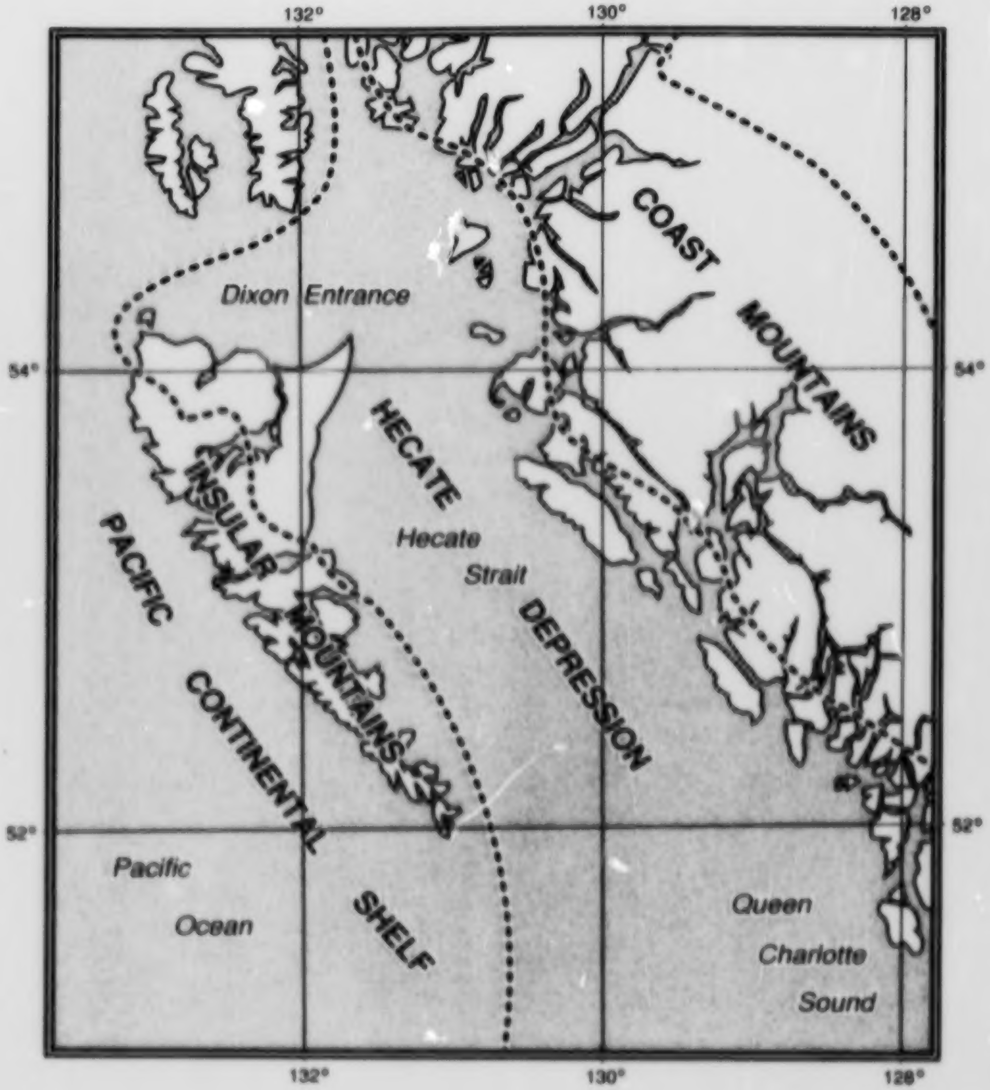
132°
130°
128°
54°
52°
COAST MOUNTAINS
Dixon Entrance
HECATE
Hecate
Strait
DEPRESSION
INSULAR
MOUNTAINS
PACIFIC
CONTINENTAL
SHELF
Pacific
Ocean
Queen
Charlotte
Sound

Figure 11. Major physiographic divisions of the marine area (after Holland 1976)

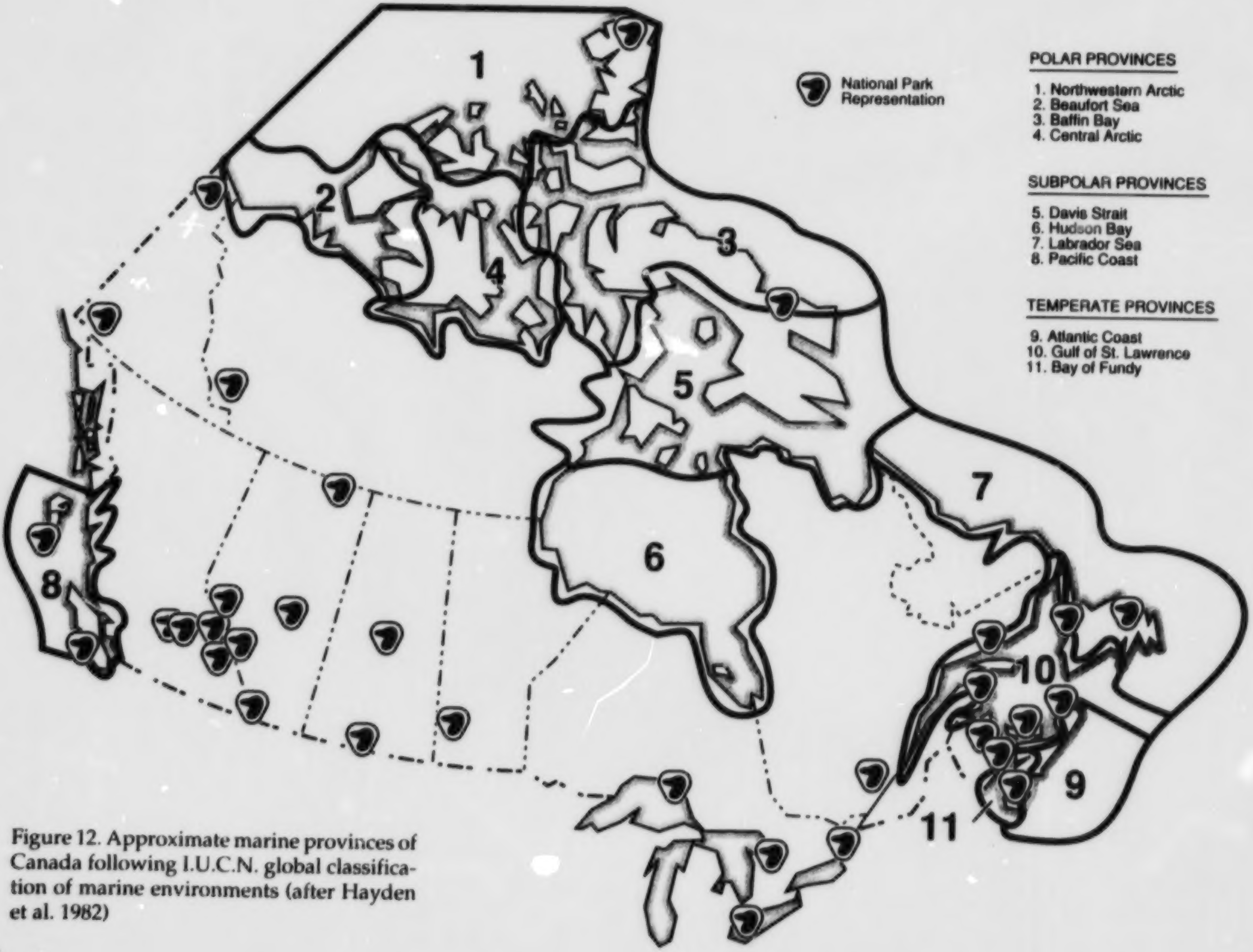
1
2
3
4
5
6
7
8
9
10
11
National Park Representation
POLAR PROVINCES
1. Northwestern Arctic
2. Beaufort Sea
3. Baffin Bay
4. Central Arctic
SUBPOLAR PROVINCES
5. Davis Strait
6. Hudson Bay
7. Labrador Sea
8. Pacific Coast
TEMPERATE PROVINCES
9. Atlantic Coast
10. Gulf of St. Lawrence
11. Bay of Fundy

Figure 12. Approximate marine provinces of Canada following I.U.C.N. global classification of marine environments (after Hayden et al. 1982)

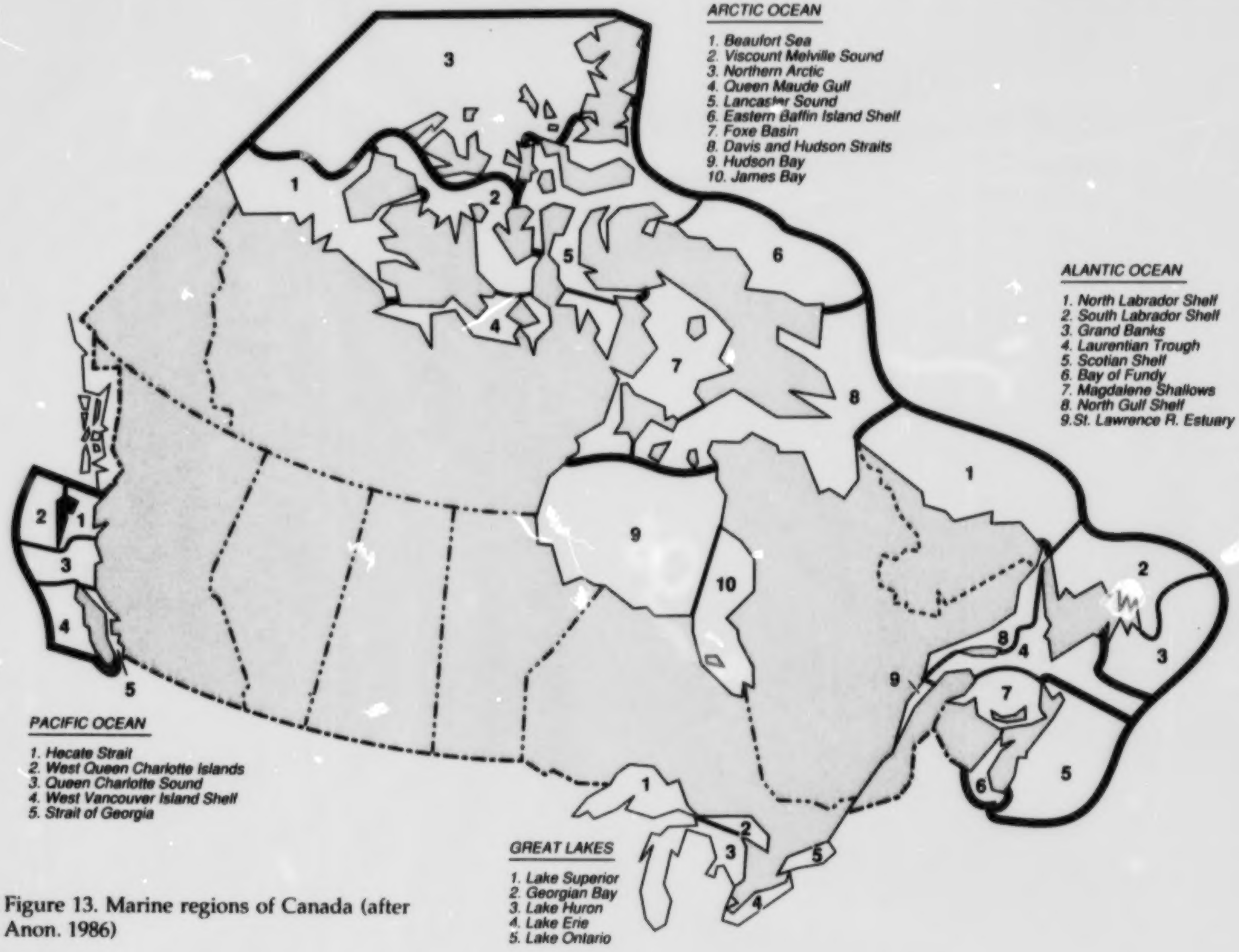
ARCTIC OCEAN
1. Beaufort Sea
2. Viscount Melville Sound
3. Northern Arctic
4. Queen Maude Gulf
5. Lancaster Sound
6. Eastern Baffin Island Shelf
7. Foxe Basin
8. Davis and Hudson Straits
9. Hudson Bay
10. James Bay
ALANTIC OCEAN
1. North Labrador Shelf
2. South Labrador Shelf
3. Grand Banks
4. Laurentian Trough
5. Scotian Shelf
6. Bay of Fundy
7. Magdalene Shallows
8. North Gulf Shelf
9.St. Lawrence R. Estuary
PACIFIC OCEAN
1. Hecate Strait
2. West Queen Charlotte Islands
3. Queen Charlotte Sound
4. West Vancouver Island Shelf
5. Strait of Georgia
GREAT LAKES
1. Lake Superior
2. Georgian Bay
3. Lake Huron
4. Lake Erie
5. Lake Ontario
1
2
3
4
5
6
7
8
9
10

Figure 13. Marine regions of Canada (after Anon. 1986)

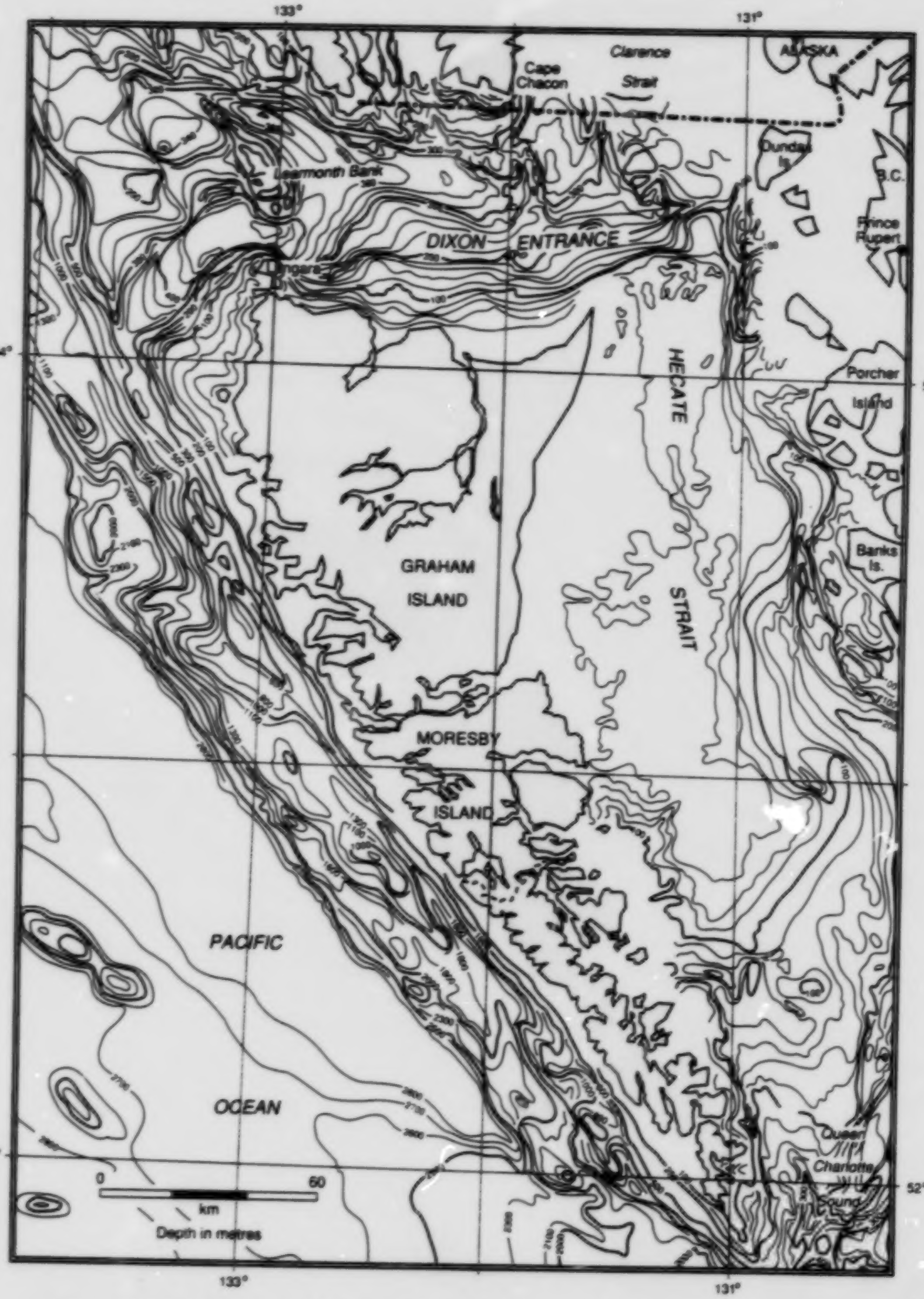
133°
131°
Cape Chacon
Clarence Strait
ALASKA
Dundas Is.
B.C.
Prince Rupert
Learmonth Bank
DIXON ENTRANCE
Langara
54°
HECATE
Porcher Island
GRAHAM ISLAND
STRAIT
Banks Is.
MORESBY ISLAND
PACIFIC
OCEAN
Queen Charlotte Sound
52°
0
60
km
Depth in metres

Figure 14. Bathymetry of Queen Charlotte Island area (after Seeman 1982)

The counterpart, in the marine context, to the Geographical Regions of Canada defined by the Canadian Parks Service in 1972 (refer to *The Natural Terrestrial Regions of Canada*) are the Marine Provinces of Canada, which were described following the global classification of marine environments adopted by the International Union for the Conservation of Nature and Natural Resources (Ray 1975; Hayden *et al.* 1982). Based on earlier work by Howard Paish and Associates (Anon. 1970), the Systems Planning Division (Anon. 1970) distinguished nine different Marine Natural Regions based on physical and oceanographic criteria. This was further refined in 1983 (Harper *et al.*) and introduced to the public in 1986 (Anon.) as the 29 Marine Regions on the three oceans and the Great Lakes which we recognize today.

The marine portion of South Moresby / Gwaii Haanas National Park Reserve is a representative of three Marine Regions of Canada on the Pacific Coast: The West Queen Charlotte Islands Marine Region, the Hecate Strait Marine Region, and the Queen Charlotte Sound Marine Region. All three regions owe their distinction in part to the bathymetry of the areas.

The West Queen Charlotte Islands Marine Region encompasses the west coast waters off the Queen Charlotte Islands. Beyond bathymetric discrimination, the Marine Region is further distinguished by offshore marine circulatory patterns which cause waters to mix to such an extent that a relative homogeneity of temperature and salinity results.

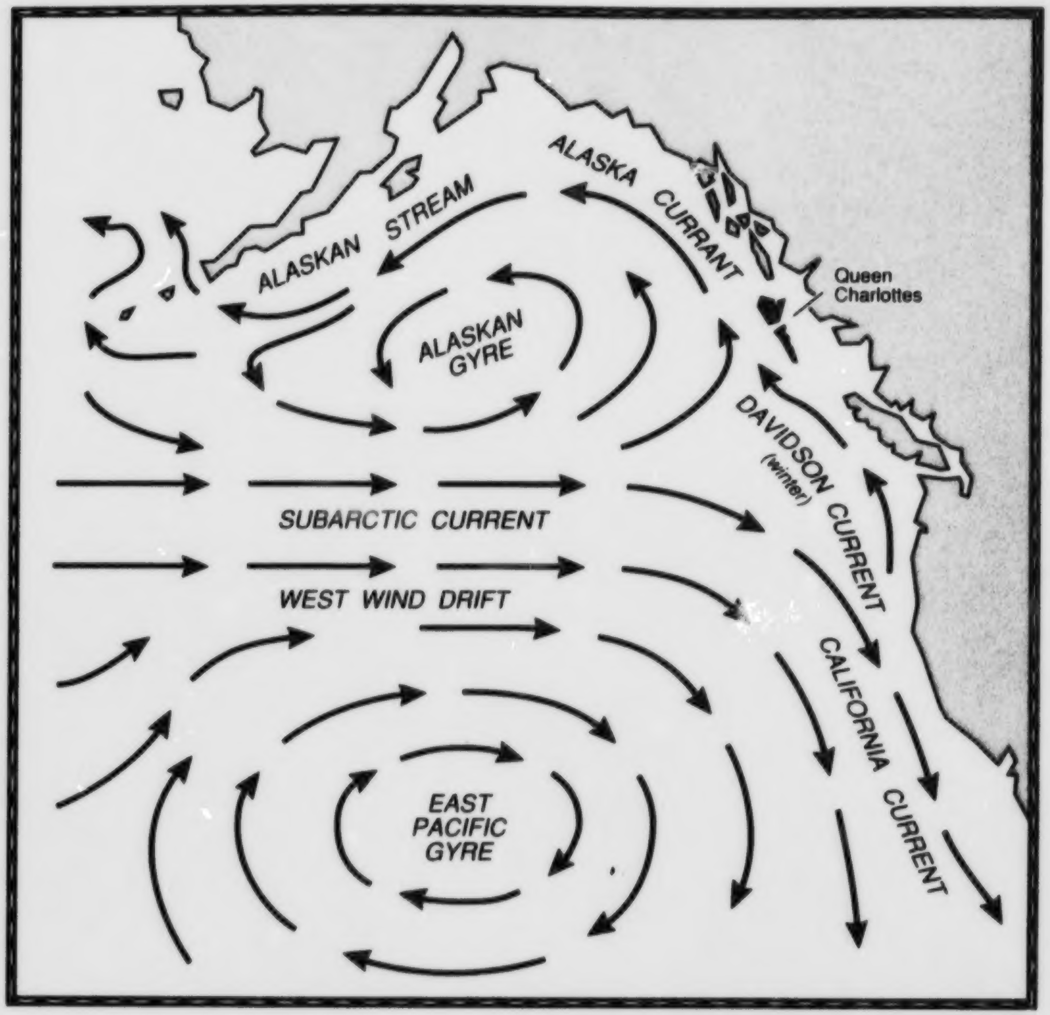

Figure 15. Surface currents in the northeast Pacific Ocean (after Thomson 1981)

The Hecate Strait Marine Region is comprised of Dixon Entrance and Hecate Strait. There, due to the shallow depths and the sheltered nature of the waters, mixing occurs neither as regularly nor as deeply as is the case in Pacific Ocean waters. Though there may be a degree of agitation associated with narrow passages subject to tidal influences, the circulatory patterns are not generally as turbulent as those offshore.

Both, a semi-protected circulatory pattern and a shallowing bathymetry, characterize the Queen Charlotte Sound Marine Region. The region is neither as calm nor as shallow as the Hecate Strait, but its position over the Continental Shelf and its partially-enclosed situation afford it more calm, shallow waters than those of the west coast of the Queen Charlottes.

Surrounding as it does the southern portion of Moresby Island, the marine portion of South Moresby/Gwaii Haanas National Park Reserve overlies portions of Hecate Strait, Queen Charlotte Sound, and the Continental Shelf.

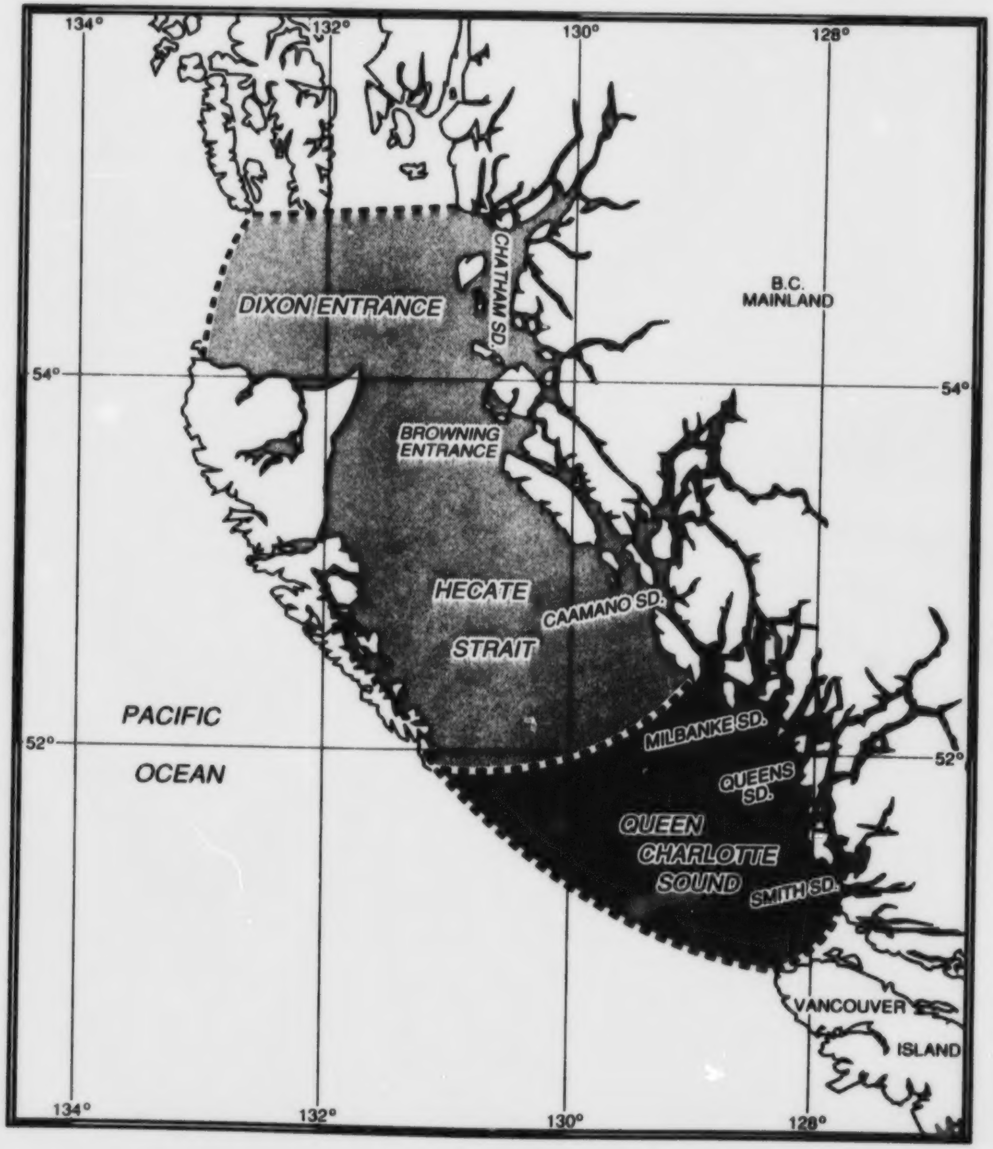
134°
132°
130°
128°
54°
52°
DIXON ENTRANCE
CHATHAM SD.
B.C. MAINLAND
BROWNING ENTRANCE
HECATE STRAIT
CAAMANO SD.
PACIFIC OCEAN
MILBANKE SD.
QUEENS SD.
QUEEN CHARLOTTE SOUND
SMITH SD.
VANCOUVER ISLAND

Figure 16. Semi-protected (dark shade) and sheltered (med. shade) inshore waters of the Queen Charlotte Islands region.

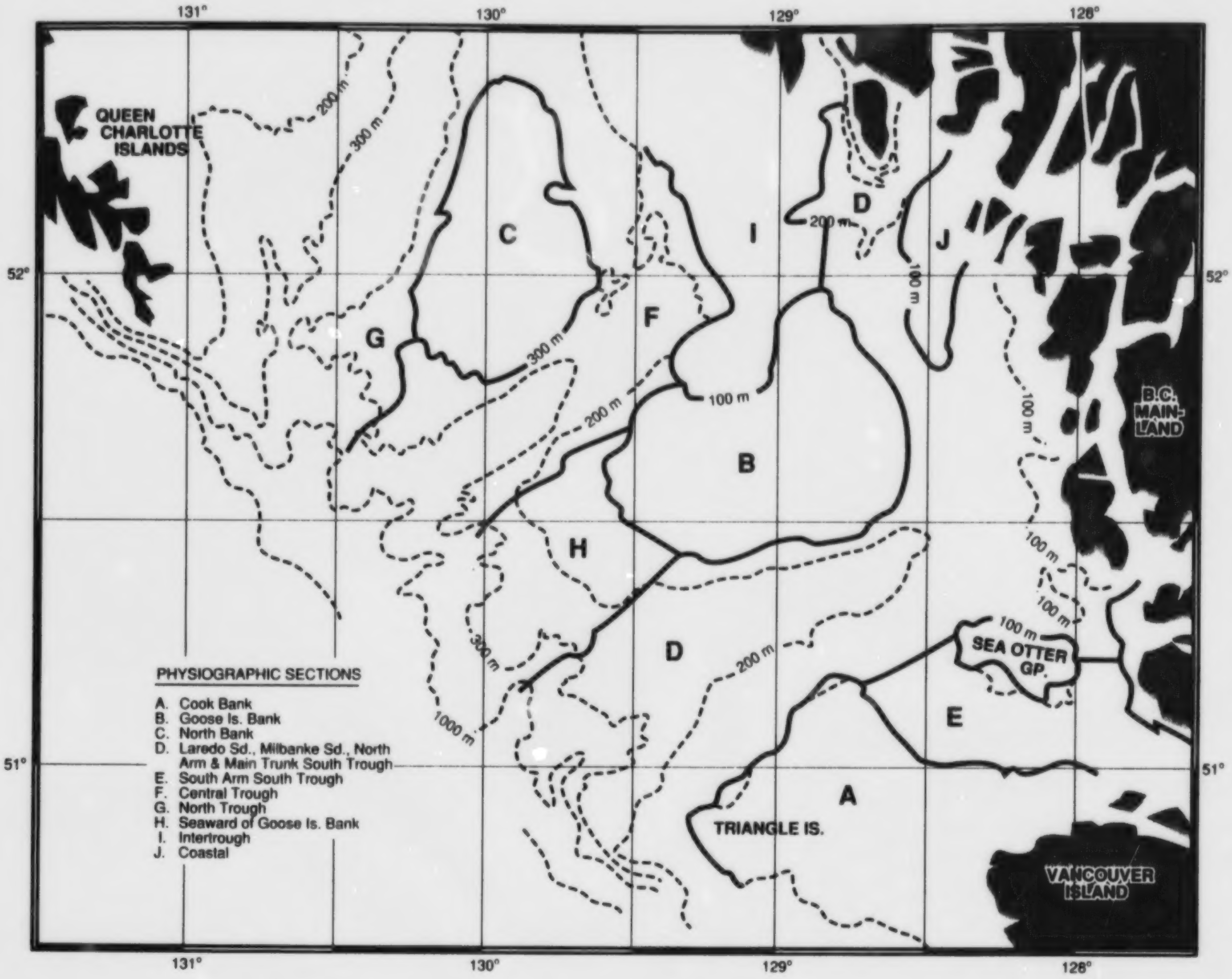
131°
130°
129°
128°
52°
51°
QUEEN CHARLOTTE ISLANDS
B.C. MAIN-LAND
VANCOUVER ISLAND
SEA OTTER GP.
TRIANGLE IS.
200 m
300 m
100 m
1000 m
A
B
C
D
E
F
G
H
I
J
PHYSIOGRAPHIC SECTIONS
A. Cook Bank
B. Goose Is. Bank
C. North Bank
D. Laredo Sd., Milbanke Sd., North Arm & Main Trunk South Trough
E. South Arm South Trough
F. Central Trough
G. North Trough
H. Seaward of Goose Is. Bank
I. Intertrough
J. Coastal

Figure 17. Physiographic sections of Queen Charlotte Sound (from Luernauer 1972)

Shallowest of the major channels which make up the Hecate Depression, Hecate Strait separates the Queen Charlotte Islands from the mainland with a 220 kilometres long submarine valley close to its eastern shore. Some 300 metres deep at its southern end, the valley shallows to 50 metres at its northern extremity. Off Graham Island, in the northwestern corner of Hecate Strait, is a submarine extension of the Charlotte Lowlands. Rough sea conditions can easily develop over the glacial sands and gravels of the broad ledge which extends to 100 metres in depth.

Queen Charlotte Sound exhibits a much more complex bathymetry. Three wide troughs extend inland across the Ccontinental Shelf from depths of 350-400 metres and are separated by broad, shallow banks. The northern-most trough is both the most extensive and the most lacking in uniformity. Forming the southerly entry to the deep channel of Hecate Strait, it bears in a northerly direction for 270 kilometres along faulted depressions which have been deepened by glaciation. The central and southern troughs shallow out more regularly as they trend towards the mainland coast. Recessional moraines and stream outwash deposits, also a relic of glacial recession, account for the origins of the broad banks which intersperse the three troughs (Thomson 1981).

The Continental slope off the west coast of Moresby Island does not exhibit a Continental rise. Instead, a very narrow Continental Shelf and slope are interrrupted by a 300 kilometres long, sediment-filled trough. The Continental Shelf, as determined by the 200 metre depth contour, is rarely wider than 5 kilometres, and it slopes at grades of 10-15 percent to depths of greater than 2500 metres in less than 30 kilometres. Sediments coming down the slope fill the 55 kilometre wide, 3 kilometre deep trough. Seaward of the Queen Charlotte Trough lies the wide, gently sloping, Oshawa Rise.

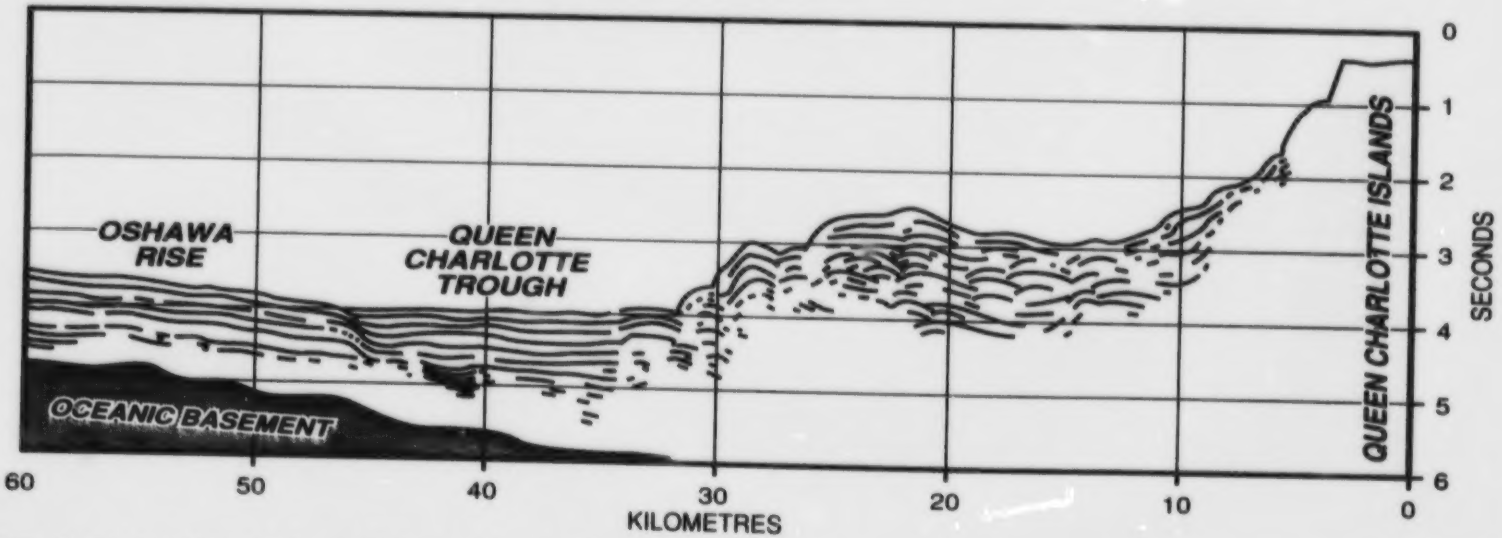

Figure 18. The Continental slope off the southern Q. C. Islands. Note: sound depths are measured in seconds (after Chase et al. 1975)

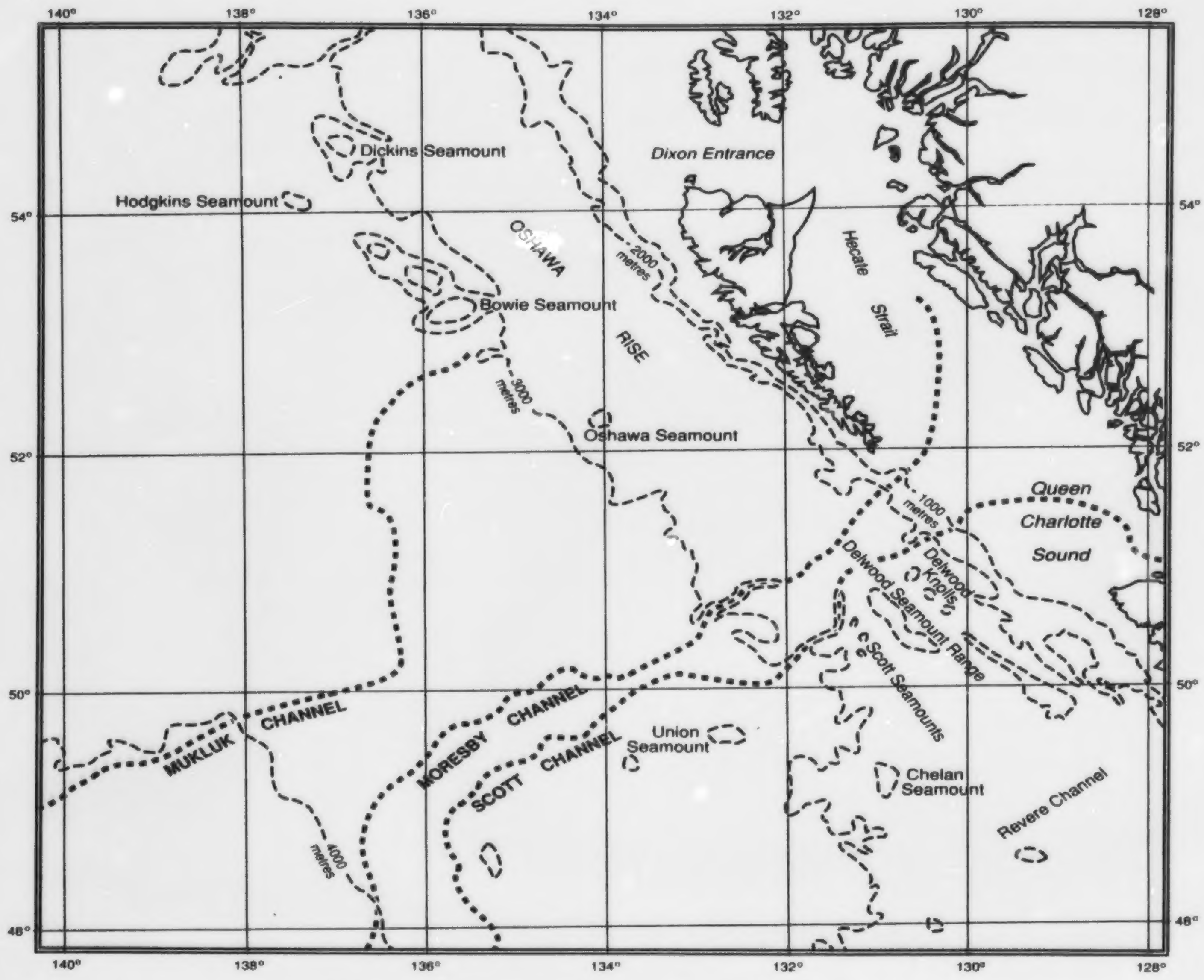
140°
138°
136°
134°
132°
130°
128°
54°
52°
50°
48°
Dickins Seamount
Dixon Entrance
Hodgkins Seamount
OSHAWA
2000 metres
Hecate
Strait
Bowie Seamount
RISE
3000 metres
Oshawa Seamount
1000 metres
Queen
Charlotte
Sound
Delwood Knolls
Delwood Seamount Range
Scott Seamounts
CHANNEL
MUKLUK
MORESSBY
CHANNEL
SCOTT
CHANNEL
Union Seamount
Chelan Seamount
Revere Channel
4000 metres

Figure 19. Bathymetry of northwest offshore waters

The gradual incline of the open sea floor is broken by several prominent seamounts, underwater volcanic peaks rising more than 3,000 metres above the surrounding ocean floor. Of the two distinct submarine channels in the area, only Moresby Channel transects the Continental Shelf.

The first step leading to the establishment of a National Marine Park in the Queen Charlotte Sound Marine Natural Region was completed in 1977, with the identification of Natural Areas of Canadian Significance worthy of representation within the National Park System (Adkins 1977). On the basis of their representativeness, naturalness and unique biological characteristics, Adkins identified three areas deserving consideration, including the Dundas Islands, the Calvert/Hunter Islands, and east Moresby Island.

Adkins praised the representation in the east Moresby Island area of landform and marine ecosystem themes characteristic of the Queen Charlotte Sound Marine Natural Region:

There are many outstanding and unique features that make this area distinctive. In particular are the Dolomite Narrows and the remarkable density of marine flora and fauna that occur throughout the entire area. The greatest number of abalone on the British Columbia coast are found in this area.

Peregrine falcons and sea otters, two species that are close to extinction, occur on east Moresby Island. This area also supports the largest number of seabirds in British Columbia and is a crucial feeding and nesting ground for many marine birds. Cape St. James is one of only three sea lion breeding grounds on the coast, and sea lions and whales are commonly sighted throughout the area.

Special landform features of the area include: miles of exposed coastline, innumberable small islands, a hotspring, and many protected harbours suitable for boat anchorage.

In a subsequent study, Searing and English (1983) evaluated the three Natural Areas of Canadian Significance identified by Adkins, rating the east Moresby Island archipelago most highly on the ballance of factors including: representativeness. ecological integrity, opportunities for public understanding, opportunities for public enjoyment, positive impacts, negative impacts, threats to the whole of the area of South Moresby.

NATURAL THEMES	REPRESENTATION
LANDFORM THEMES (GEOLOGICAL)	
1. Estuaries	Inadequate
2. Deltas	Inadequate
3. Shallow inlets, arms & bays	good
4. Fjords	none
5. Narrows, straits, passages & channels	good
6. Shoals, reefs, bars & banks	good
7. Islands	good
8. Exposed coastline, headlands & cliffs	good
9. Lagoons & marshes	some
10. Beaches, spits & hooks	some
11. Submerged canyons, cliffs, caves & spring	some
12. Hotsprings	good
MARINE ECOREGION THEMES	
1. Rocky shore communities	good
2. Muddy shore communities	some
3. Sand shore communities	inadequate
4. Mixed shore communities	good
5. Tide pool communities	good
6. Brackish pond & estuarine communities	inadequate
7. Salt Marshes	some
8. Pelagic habitats	good
9. Marine bird habitats	good
10. Marine mammal habitats	good
11. Marine flora & fauna spawning areas	good
12. Man-made habitats	good
OCEANOGRAPHIC THEME	
1. Tide & tide processes	tidal range - 3.5 metres
2. Currents (surface & subsurface)	extensive
3. Upwellings	extensive
4. Downwellings	extensive
5. Freshwater influences	negligible
6. Whirlpools	none known
7. Planktonic production Zone - pelagic	Hecate Strait
8. Ocean fronts	no usual fronts
9. Windrows	no information
10. Oxygen deserts	no information
11. Deeps	no extremely deep water
12. Splash zones	some
13. Water temperature	variable, average 9°C
14. Salinity	variable, average 31‰
15. Water clarity (seasonal visibility)	good in winter
16. Water quality	good

Figure 20. Marine natural themes - East Moresby Island (after Adkins 1977)

MARINE THEMES	South Moresby Area	Proposed Park Area	% of Total in Park Area
CLIMATOLOGY	1	1	100%
OCEANOGRAPHY			
Tidal Currents	11	9	82%
Tide Rips	9	7	78%
Current Mixing	1	1	100%
COASTAL LANDFORMS			
Rock Formations	16	15	94%
Caves/Sea Arches	5	4	80%
Salt Marshes	6	4(3)	67%(50%)
Estuaries	19	13(12)	68%(63%)
Sand Beaches	4	4	100%
BIOLOGICAL RESOURCES			
Major Kelp Beds			
Nereocystis	39	38(37)	97%(95%)
Macrocystis	36	32	89%
Invertebrates			
Diversity Recreational Harvests Commercial Harvests	NO SIGNIFICANT DIFFERENCE		100%
Fish			
Halibut	5	5	100%
Herring Spawning	21	15	71%
Salmon Spawning	43	32(31)	74%(72%)
Seabird Colonies	53	51(50)	96%(94%)
Seabird Staging Areas	13	13	100%
Mammals	NO SIGNIFICANT DIFFERENCE		100%
MAN-MADE STRUCTURES			
Docks, Wharves, etc.	15	9	60%
Other Structures	26	19	73%
Native Villages	54	43(40)	80%(74%)
Shipwrecks	9	5	56%
Fossil Sites	20	15(14)	75%(70%)

( ) value if key areas near proposed park boundary are omitted from park

Figure 21. Marine themes in the South Moresby area (after Searing 1987)

a) RESOURCE ANALYSIS

The present status of the marine component of the South Moresby/Gwaii Haanas National Park Reserve is that of a proposed Marine National Park Reserve pending the decision on the boundary by the end of 1992, or earlier. The commitment to establish the reserve was made on the part of the federal and provincial governments in July of 1987, but a great deal of data gathering and analysis must be accomplished before decision-makers can do justice to the natural, economic and cultural values of the area in their deliberations over the future of the proposed National Park Marine Reserve. Both the perceived status and purpose of the reserve within a regional context will be determined to a great extent on the basis of the manner in which both the federal-provincial "Memorandum of Agreement" and the land claims of the Haida Nation are resolved.

- Management Concerns

Present management concerns are to ensure that the protection, development, management, operation, and use of the reserve be consistent with the National Parks Policy (Anon. 1983b), while addressing concerns of the visiting public, the Haida Nation, other area residents, and resource users.

From a marine perspective, the urgent concern is to understand the potential impacts of any development within the region on the role that the marine park reserve is to play in the national park system. The successful resolution of this concern relies upon the cooperative efforts of the park managers and other governments and interests. The new National Parks Policy (in preparation) and the Park Management Plan for South Moresby/Gwaii Haanas National Park Reserve, both of which are underway, are expected to abet that cooperation.

- Status of Knowledge

The same paucity of regional knowledge which applies to the terrestrial region of which the Queen Charlotte Islands are a part, also applies to the associated marine region. There is a dearth of information on marine tourism specific to the area of Queen Charlotte Sound and the offshore waters. As well, studies of the marine natural region are, for the most part, of an age and generality that they cannot serve as the basis for responsible resource management. The two most comprehensive of studies are by Petro-Canada Inc. (Anon. 1983a) and Chevron Canada Resources Ltd. (Anon. 1982). The most recent of such studies are both by MacLaren Plansearch (Anon. 1987 and 1988c). One purpose in doing a thorough literature review in the course of this Provisional Resource Description and Analysis, is that, by its final completion in a few years, many of the present knowledge gaps will have been bridged.

b) SELECT REFERENCE SOURCES

Anonymous 1972.
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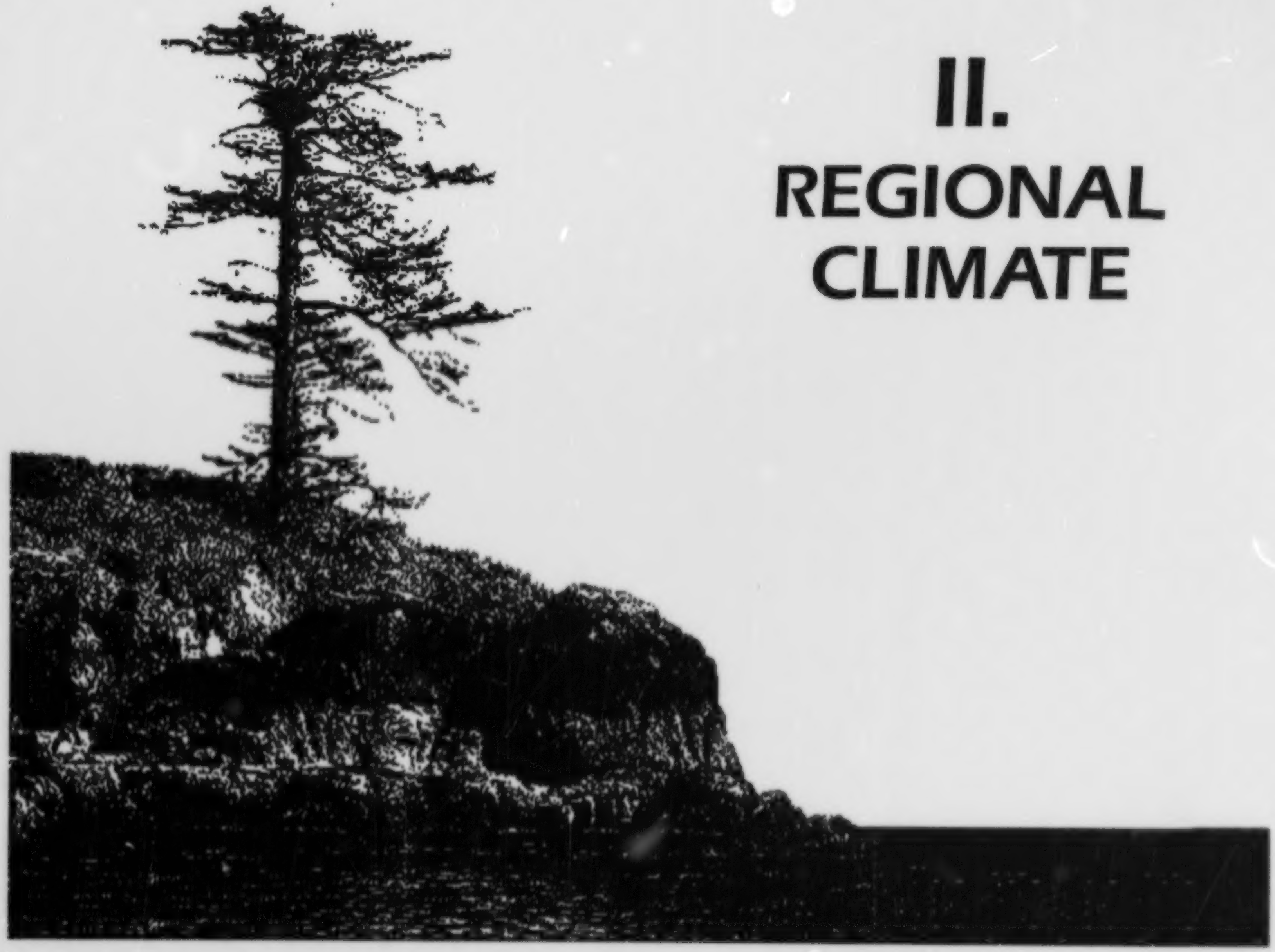
Chase, R.L., D.L. Tiffin, & J.W. Murray 1975.
The Western Canadian Continental Margin. IN C.J. Yorath, E.R. Parker & D.J. Glass (eds.): Canada's Continental Margins and Offshore Petroleum Exploration. Can . Soc. Pet. Geol., Calgary. Mem. 4:701-721. Calgary. Mem. 4 : 701-721.

Holland, S.S. 1976.
Landforms of British Columbia:A Physiographic Outline. British Columbia Department of Mines and Petroleum Resources Bulletin 48, Victoria, B.C. 138p., map.

Thompson, R.E. 1981.
Oceanography of the British Columbia Coast. Can. Spec. Publ. Fish. Aquat. Sci. 56. 291 p.

II.
REGIONAL CLIMATE



REGIONAL CLIMATE

General Overview

The peculiar distribution of sea, mountains and land along the northwestern coast of North America, produces a very distinctive climatic pattern that exhibits weather variability largely affected by the geography. Bryson & Hare (1974) visualized the North American climatic situation as:

> **. . . a simple model of the topography imbedded in the general circulation of the atmosphere, and stretching from tropical seas at 15 degrees N (50 degrees N in the east) with an excess of net radiation, to polar lands and ice-covered sea at latitude 70-80 degrees N, with a small deficit of net radiation.**

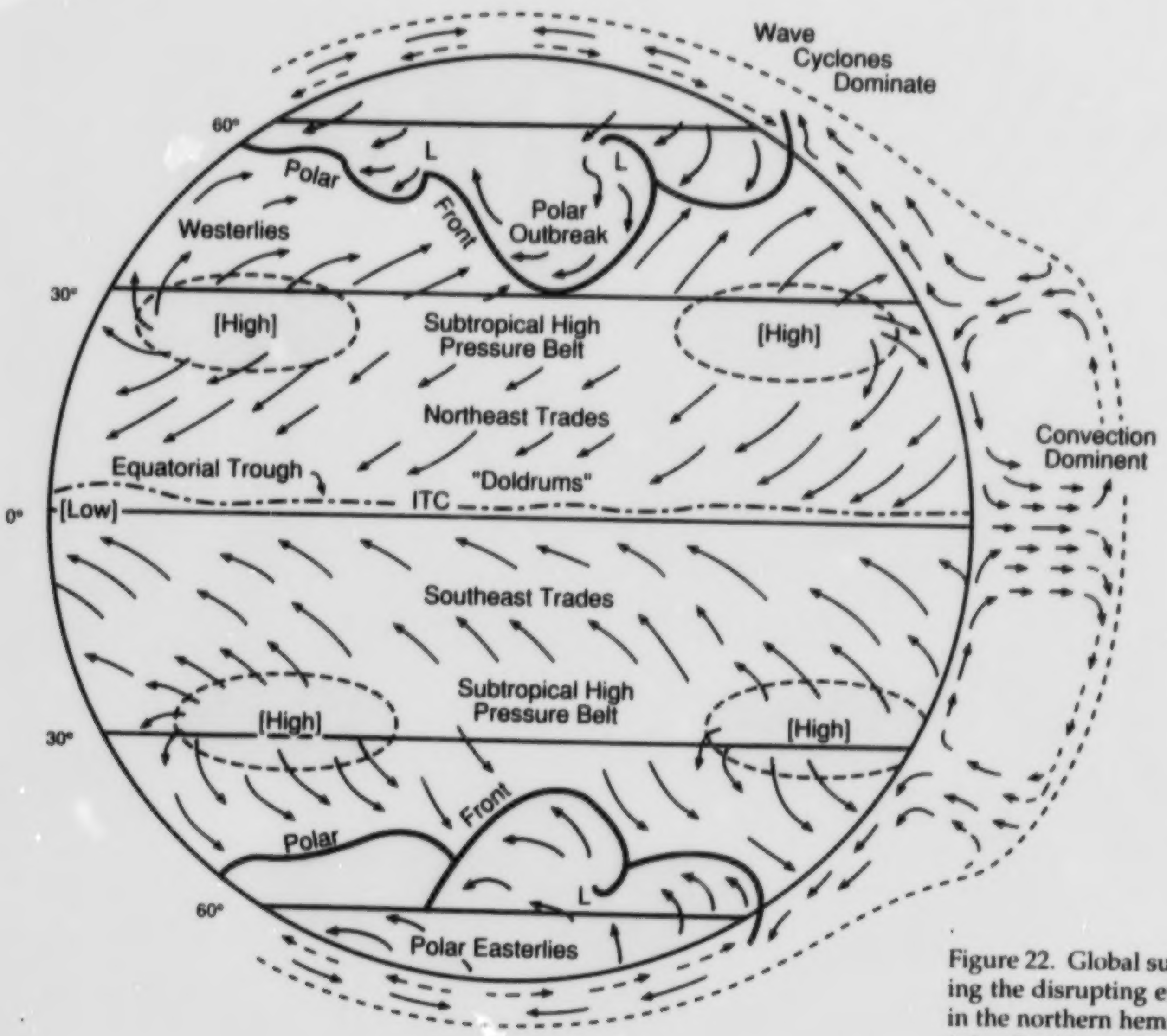
In the larger picture, the North American climate is driven by the globally-belted arrangement of pressure zones with patterns of surface winds that are convection dominant between the equator and about 30 degrees N, and then become wave cyclone dominant as they approach the polar regions. Between Latitude 35 degrees N and 60 degrees N, the wave cyclonic winds form a distinct belt of prevailing westerly winds that find their strength and persistence disrupted only by the presence of vast land masses and mountain ranges (Strahler & Strahler 1983).

Three main routes are recognized whereby the low-level "westerlies" approach the northwestern coast of North America and then cross the Cordillera (Bryson & Hare 1974):

(1) near latitudes 45-50 degrees N, where they are on the average the strongest;

(2) through the Columbia River-Snake River-Wyoming Basin gap; and . . .

(3) through the lower region along the Mexican-United States border.



Wave
Cyclones
Dominate
60°
L
Polar
L
Front
Polar
Outbreak
Westerlies
30°
[High]
Subtropical High
Pressure Belt
[High]
Northeast Trades
Convection
Dominent
Equatorial Trough
"Doldrums"
0°
[Low]
ITC
Southeast Trades
Subtropical High
Pressure Belt
30°
[High]
[High]
Front
Polar
L
60°
Polar Easterlies

Figure 22. Global surface winds (disregarding the disrupting effect of large continents in the northern hemisphere)
(after Strahler & Strahler 1983)

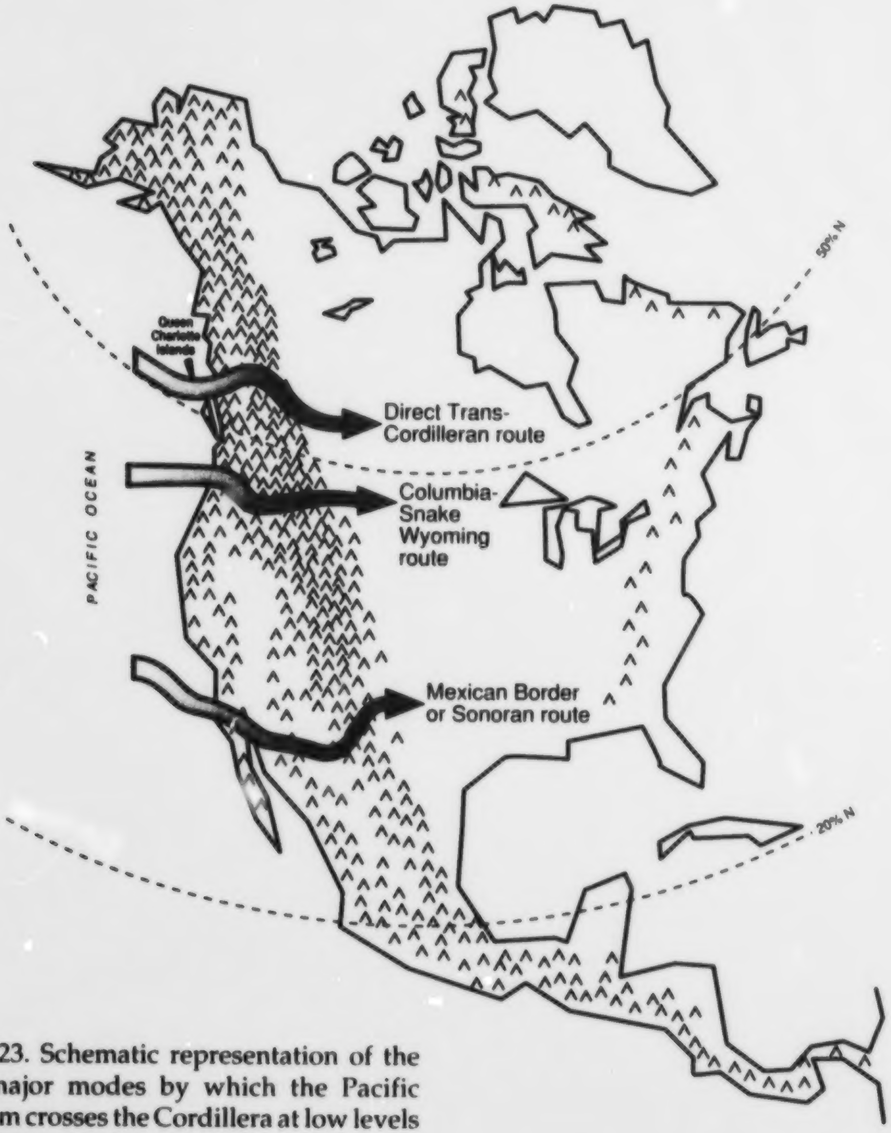

Queen Charlotte Islands
Direct Trans-Cordilleran route
Columbia-Snake Wyoming route
Mexican Border or Sonoran route
PACIFIC OCEAN
50° N
20° N

Figure 23. Schematic representation of the three major modes by which the Pacific airstream crosses the Cordillera at low levels (after Bryson & Hare 1974)

The Pacific airstream affecting the coastline of the continent has been further subdivided into the northern portion which enters the Pacific from Asia, primarily during the winter months; and the southern portion which results from an oceanic anticyclone over the Pacific and which is most prominent during the summer months. It dominates western Mexico during most of the year. It is the northern portion of the Pacific airstream with its cool temperature, near moist-adiabatic lapse rate, and high humidity, that makes its effect felt over the Queen Charlotte Islands and the regional coastline of the mainland (Bryson & Hare 1974).

Furthermore, while the main determining climatic factors of the Queen Charlotte Islands are the vast Pacific Ocean to the west, the rugged topography of the Islands, and the mountain barrier of the Cordillera to the east, it is the behaviour of certain features of the broad regional atmospheric circulation that actually provides the locally important airmasses; i.e. the prevailing westerlies, the Aleutian Low, and the North Pacific High (Calder & Taylor 1968; Klein 1957).

The Aleutian Low is most active during the autumn and winter months, when the temperature differences between the relatively warm waters of the ocean and the cold mainland landmass are the greatest. This extensive and highly mobile area of low pressure begins to exert its dominance over the regional climate pattern by late September, following the weakening and southward

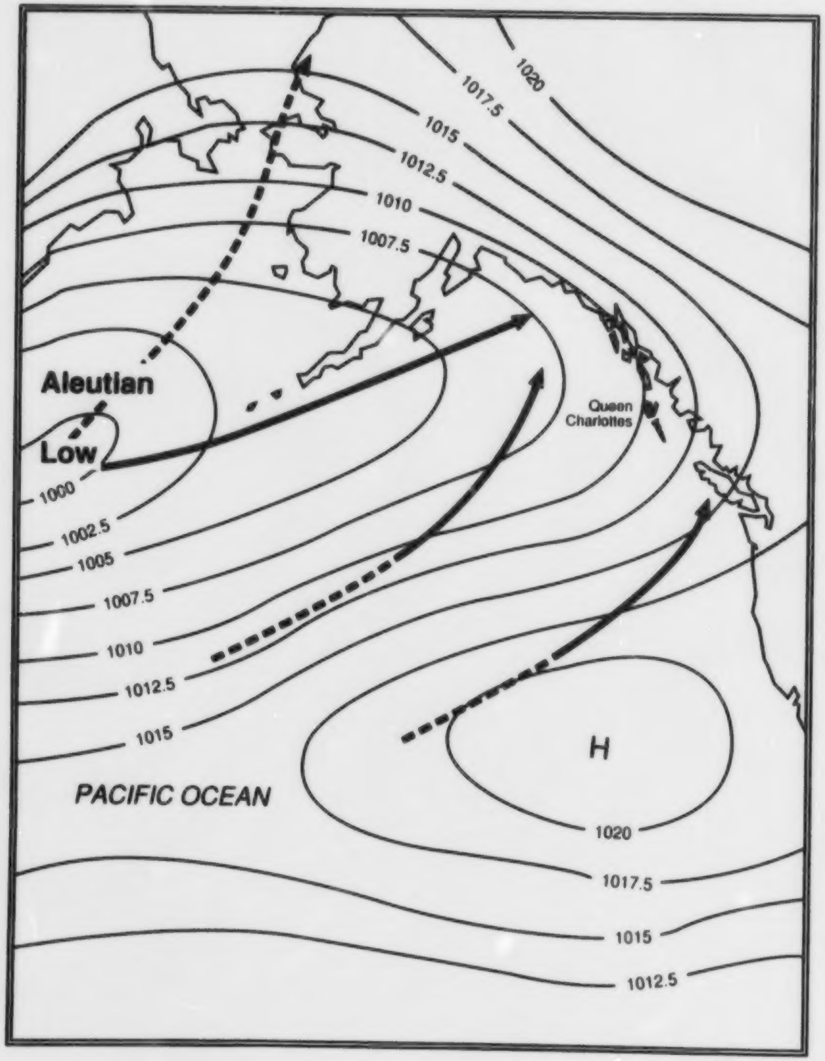

Aleutian
Low
1000
1002.5
1005
1007.5
1010
1012.5
1015
1017.5
1020
Queen Charlottes
H
PACIFIC OCEAN
1020
1017.5
1015
1012.5

Figure 24. Normal January sea-level presssure in millibars, showing the Aleutian Low (after Calder & Taylor 1968)

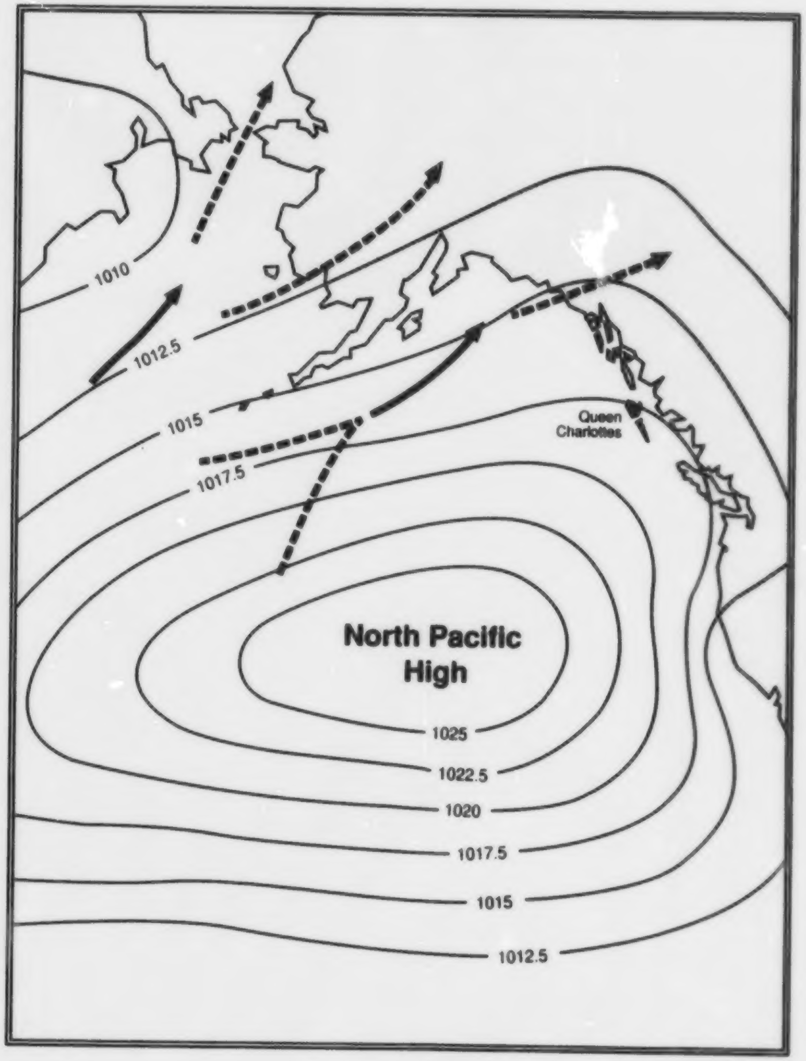

1010
1012.5
1015
1017.5
North Pacific
High
Queen Charlottes
1025
1022.5
1020
1017.5
1015
1012.5

Figure 25. Normal July sea-level pressure in millibars, showing the North Pacific High (after Calder & Taylor 1968)

movement of the previously dominant North Pacific High. It is the cause of a succession of autumn and winter storms that bring dense cloudiness, high precipitation and strong winds to the Islands and region. By contrast, the North Pacific High is an extensive area of high pressure normally situated well off the coast of Oregon and northern California that dominates the entire British Columbia coast from mid-May to mid-September and provides primarily dry and sunny weather (Calder & Taylor 1968).

As a direct result of the seasonally arranged barometric pressure areas just described, the entire west coast of North America is exposed to a stream of cyclones, many of which attain high intensity levels. They tend to occur as large and intense occluded vortices in the Aleutian Islands-Gulf of Alaska areas, while still others develop in the mid-Pacific. Some of the cold low pressure systems may become stationary for several days off or near the coast. The resultant surface winds from the low and high pressure systems throughout the seasons have been well documented and relate directly to the three main routes the low-level westerlies take as they approach the mainland and cross the coastal areas which were described earlier.

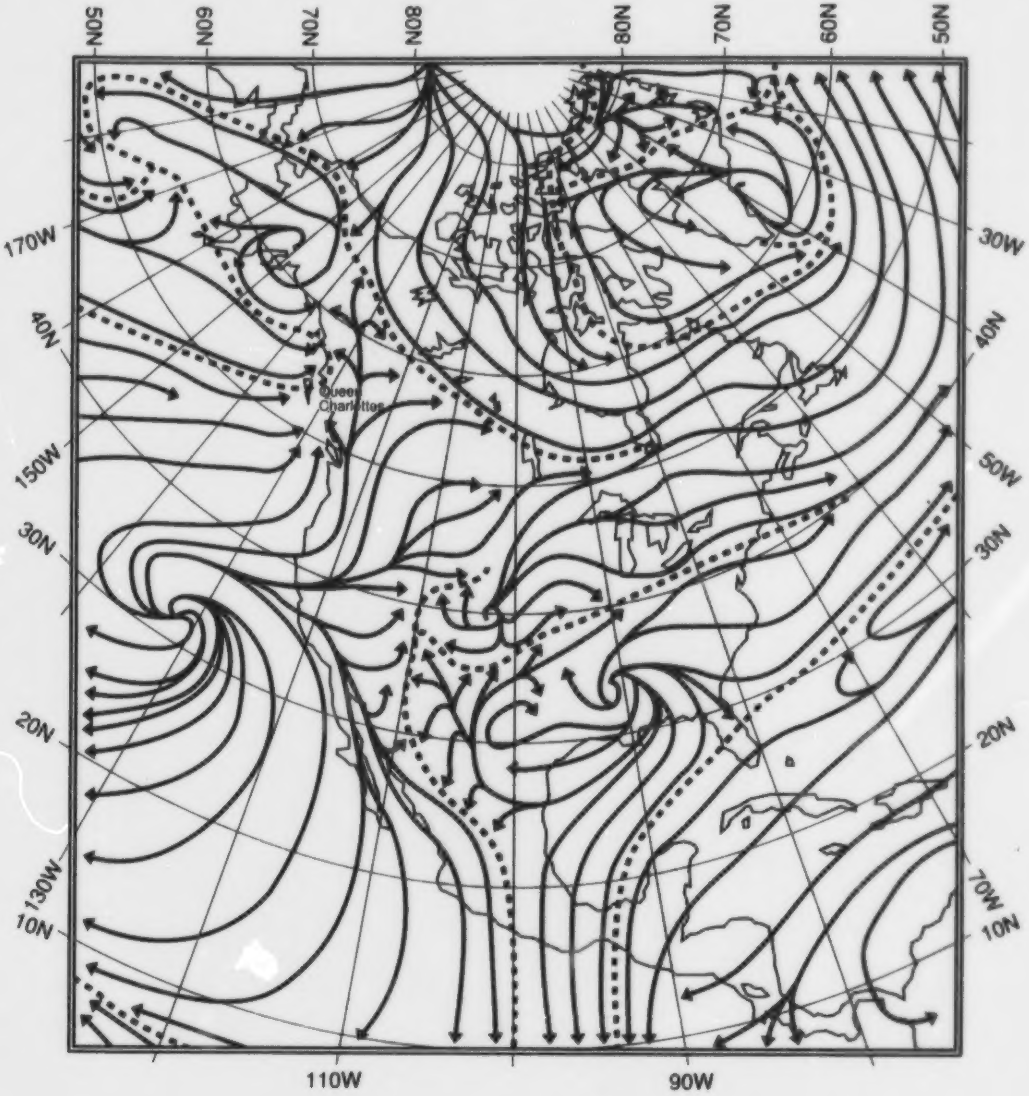


Figure 26. Resultant surface streamlines for January (after Bryson & Hare 1974)

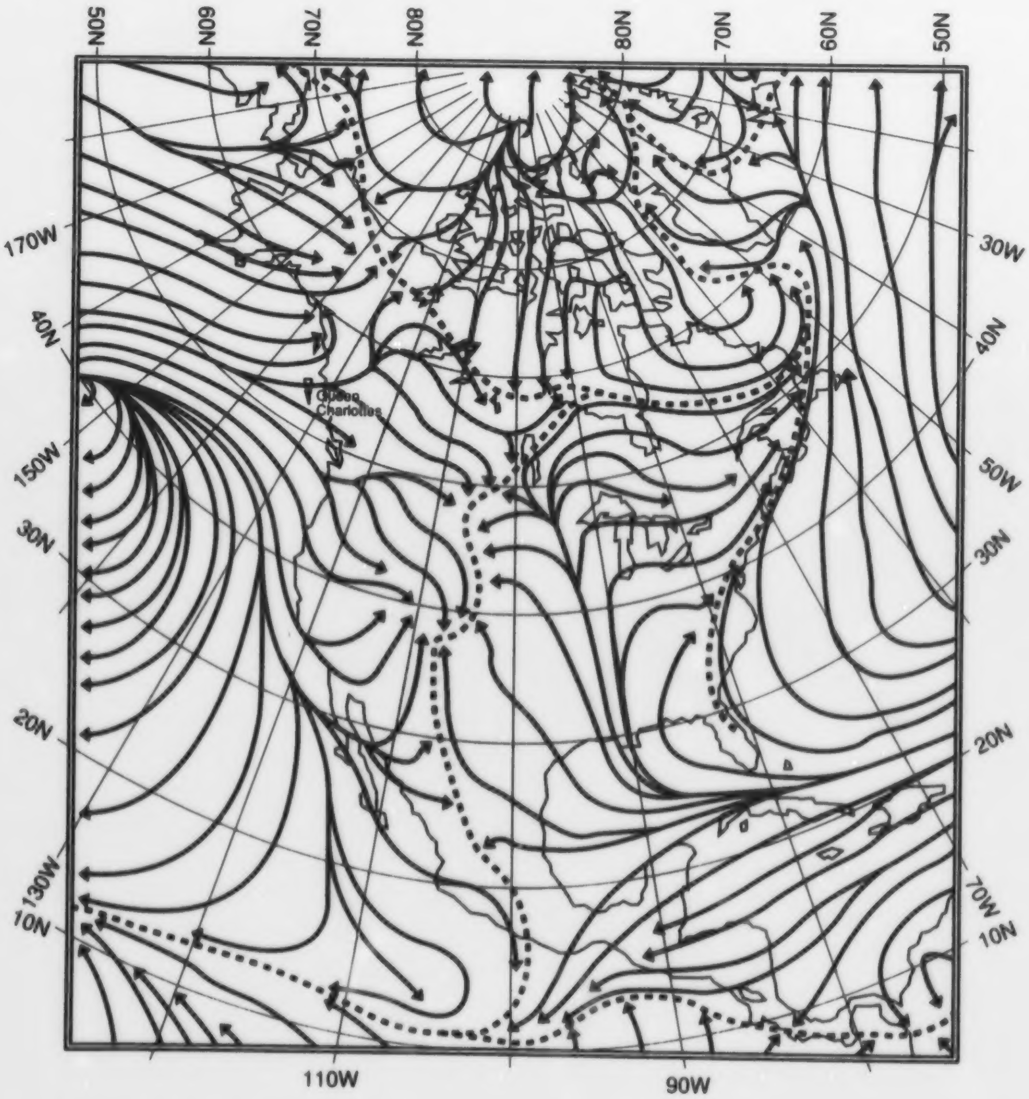


Figure 27. Resultant surface streamlines for July (after Bryson & Hare, 1974)

It has long been recognized that the monthly patterns of atmospheric circulation in interaction with topographic characteristics, surface thermal and radiation regimes, cause each place on earth to be subjected to a distinct annual sequence of dominant airstreams. Thus, they determine the climate of a place or area. Bryson & Hare (1974) refered to this phenomenon of distinct climatic assemblages as *climata*, and the regions they affect *genetic climatic regions*. More recently (Anon. 1989e), the first approximation of Canadian climatic regions was published by the Canadian Committee on Ecological Land Classification to expand the concept of distinct climatic regions across the country. Because it was recognized that the climate of a place or area corresponded well with the *biota* having developed there under its influence, the abstraction of distinct *biotic regions* soon took format. Other workers in the academic fields of climate, biology and particularly ecology have long since applied these concepts to their specific endeavours, so that in modern terminology, the Canadian landmass has been subdivided into distinct terrestrial *ecoclimatic regions/provinces*.

There is at present no comparable arrangement recognized for the climate above and within the open oceans.

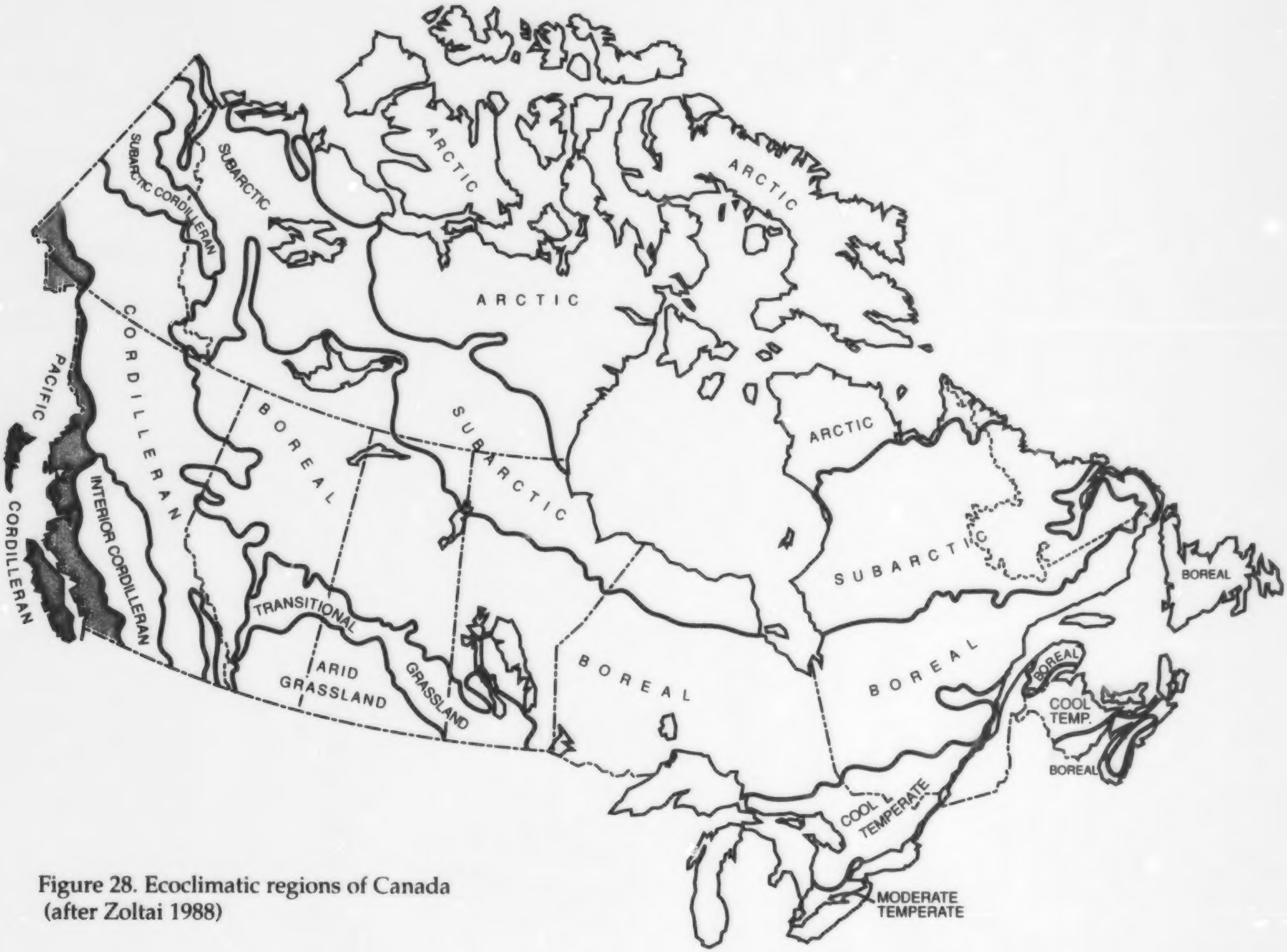

ARCTIC
ARCTIC
ARCTIC
ARCTIC
SUBARCTIC
SUBARCTIC CORDILLERAN
CORDILLERAN
PACIFIC CORDILLERAN
INTERIOR CORDILLERAN
BOREAL
SUBARCTIC
TRANSITIONAL
ARID GRASSLAND
GRASSLAND
BOREAL
SUBARCTIC
BOREAL
BOREAL
BOREAL
COOL TEMP.
BOREAL
COOL TEMPERATE
MODERATE TEMPERATE

Figure 28. Ecoclimatic regions of Canada (after Zoltai 1988)

A. TERRESTRIAL CLIMATE

Climate History

Climatic change has always been an integral physical attribute of this planet. Direct and indirect proof of past climatic changes abound in the rocks, landscapes, soils and plants. We are presently living under interglacial climatic conditions, that is to say, the Present (Flanderian) Interglacial of the Holocene Epoch which has so far at least been characterized by climatic fluctuation of only minor amplitude (Morner 1972). Morner made the point that the present climate is very likely to be replaced by a future ice age. Meanwhile, it has been established that major cold/warm changes appear to follow a cyclicity of about 10,500 years. Morner (1973) used climatic records from eustatic changes, deep sea cores, glaciation curves, fossil records and Oxygen 18 curves, to postulate that drastic, frequency-changing subcycles occur within the larger cyclicity, one varying from 230 to 1,000 years and another from 1,000 to 3,500 years in length. On the basis of that information, we have been in the second cycle which is characterized by cooler global climate, following the last ice age for some 2,200 years, and the situation is expected to continue so for another 8,300 years before the cyclicity reverses/repeats itself. Terasmae (1973) provided a tentative outline of the climatic changes that have occurred during the last glacial period and the current Holocene.

Some dates of significant Holocene environmental changes presented in radiocarbon years before the Present (Bryson *et al.* 1970), are as follows:

	Major Discontinuities:	Minor Discontinuities:
Sub-Atlantic		
	820 B.P.	
	1,680 B.P.	
	2,710 B.P.	
Sub-Boreal		
		3,660 B.P.
		4,430 B.P.
	5,180 B.P.	
		5,970 B.P.
Atlantic		
		6,740 B.P.
		7,060 B.P.
	7,900 B.P.	
Boreal		
		8,490 B.P
	9,160 B.P.	
Pre-Boreal		
	(?) 9,970 B.P.	
	(?) 10,800 B.P.	

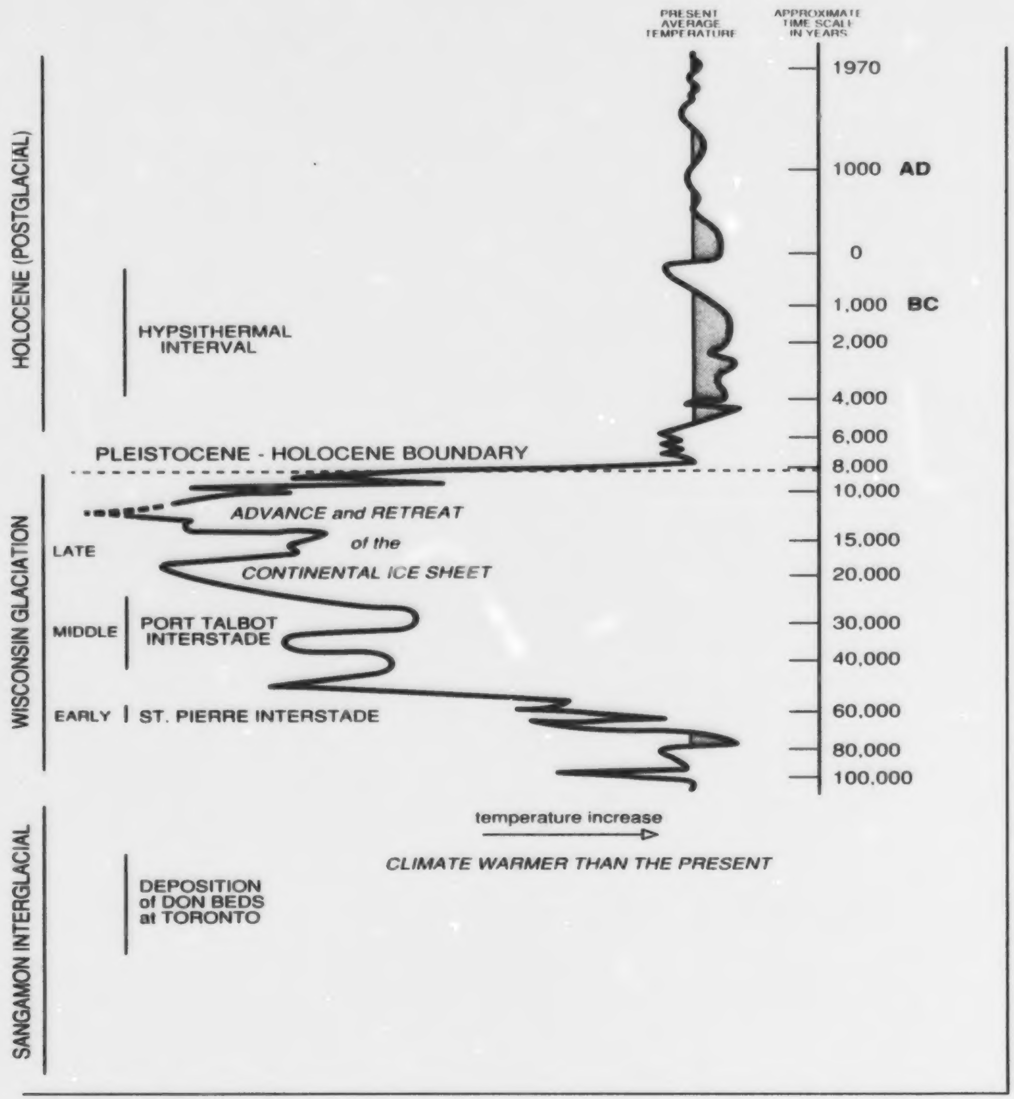


Figure 29. Tentative climatic changes during the last Glaciation and the Holocene (after Terasmae 1973)

The Queen Charlotte Islands are believed to have supported mountain icecaps as well as valley and piedmont glaciers during each of the major Pleistocene glaciations. It is also believed that the resultant glaciers were independent of the Cordilleran ice sheet on the mainland to the east, although at least one lobe of that ice sheet appears to have extended across Hecate Strait to coalesce with local glaciers on eastern Graham Island (Claque 1989).

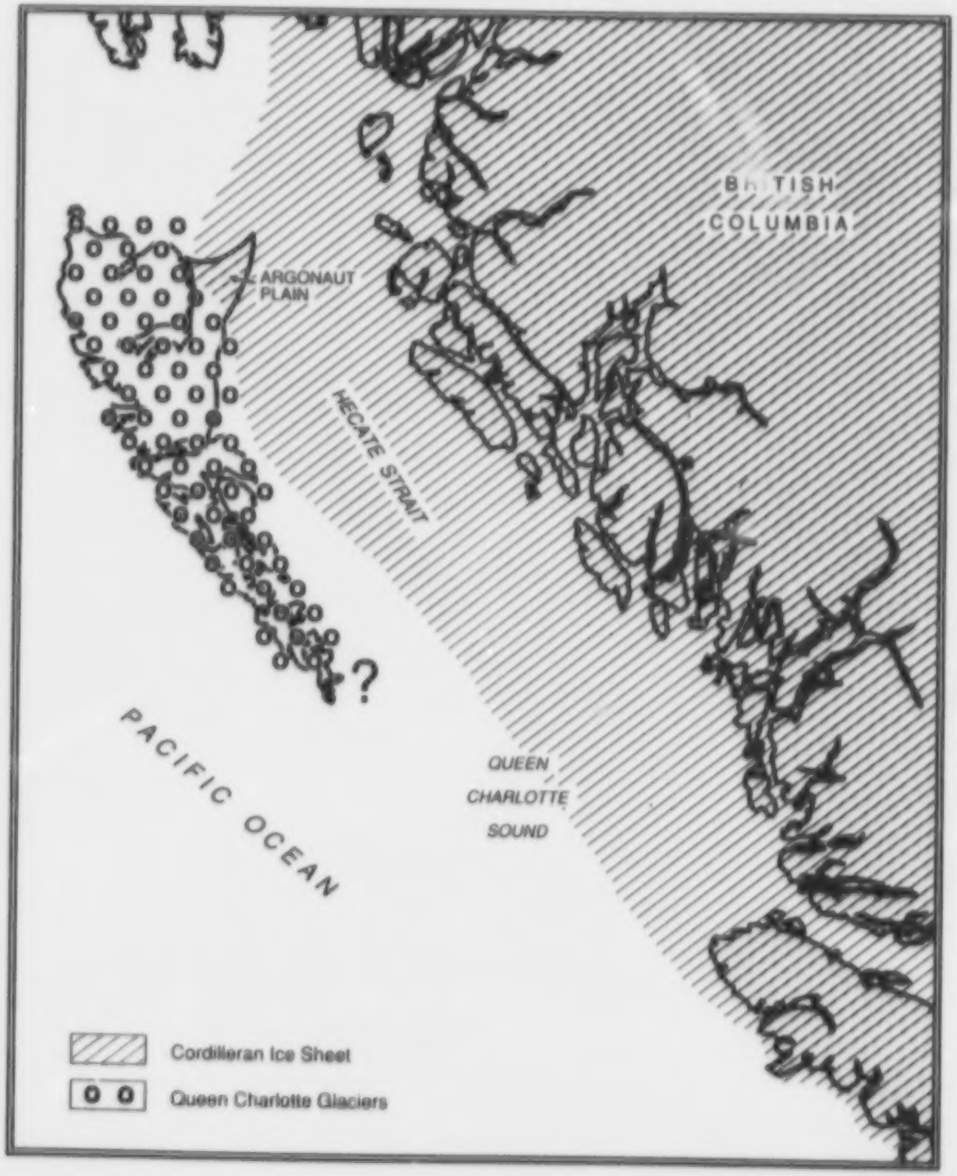

BRITISH COLUMBIA
ARGONAUT PLAIN
HECATE STRAIT
?
PACIFIC OCEAN
QUEEN CHARLOTTE SOUND
▨ Cordilleran Ice Sheet
o o Queen Charlotte Glaciers

Figure 30. Glacial coverage of the B.C. coast and the Queen Charlotte Islands (after Claque 1989)

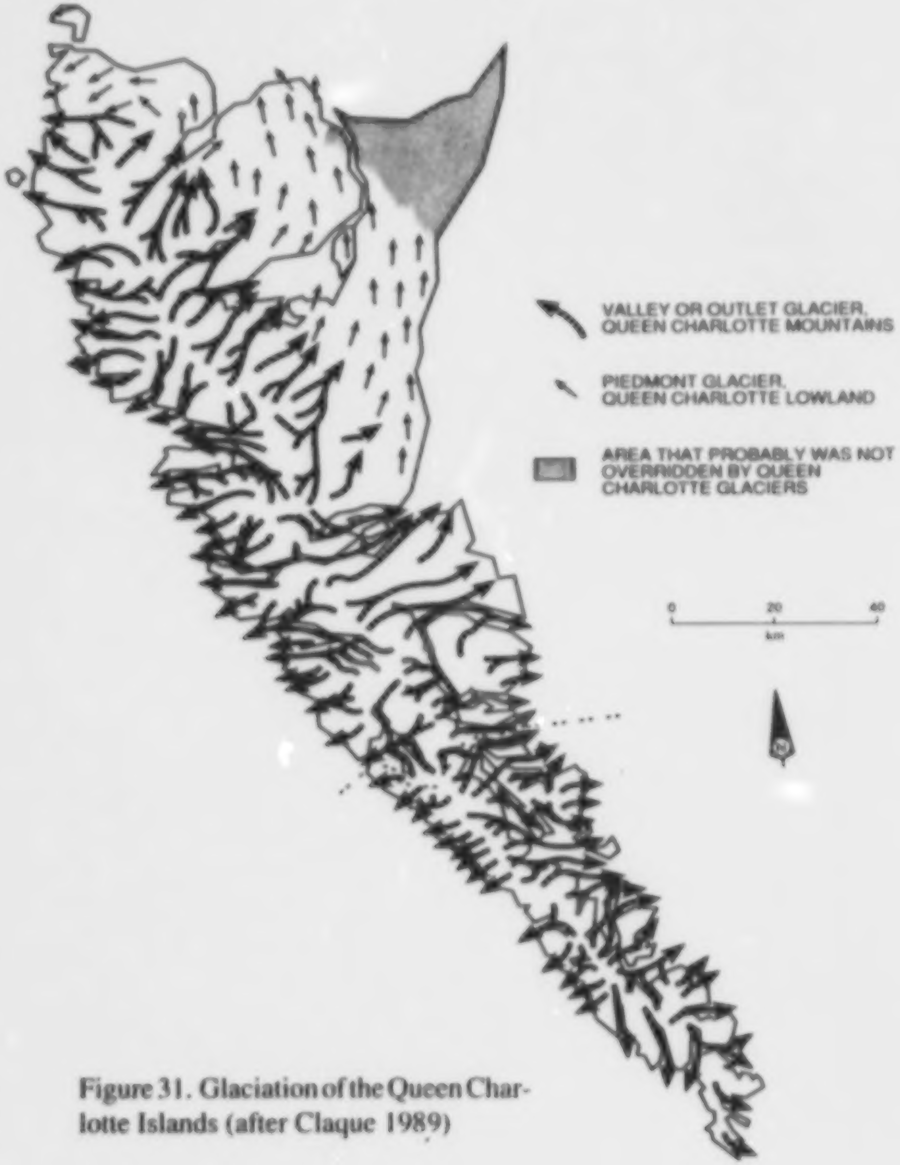

VALLEY OR OUTLET GLACIER, QUEEN CHARLOTTE MOUNTAINS
PIEDMONT GLACIER, QUEEN CHARLOTTE LOWLAND
AREA THAT PROBABLY WAS NOT OVERRIDDEN BY QUEEN CHARLOTTE GLACIERS
0
20
40
km

Figure 31. Glaciation of the Queen Charlotte Islands (after Claque 1989)

The climate regime on the Queen Charlotte Islands during Late Pleistocene times is believed to have been moderately Oceanic and cooler than the present, but quite possibly was not so severe as to preclude the survival of biota (Warner *et al.* 1982). The same researchers and Heusser (1989) have gone so far as to suggest the presence of a refugium on north-eastern Graham Island, where their geo-botanical work has indicated that ice-free land areas near past ice margins might have been available for plants, animals and occupation by early man. Heusser (1989) went so far as to suggest that:

> **The Queen Charlotte Islands formed an early late-glacial center for biotic dispersal on the glaciated North Pacific coast, predating centers in Washington and interior Alska-Yukon.**

It is believed that the glaciers began to retreat from the lowland areas of the north-eastern portion of the Queen Charlotte Islands around 16,000 years before the present. A paleo-ecological investigation at Cape Ball on the east coast of Graham Island, has produced radiocarbon dates and plant macrofossil data of a varied flora of terrestrial and aquatic plants that support that assumption. They collectively shed new light on the glacial chronology, biogeography, and climatic change that have affected the Queen Charlotte Islands (Warner *et al.* 1982).

As already alluded to, the climate of the Pacific region of Canada differs in several aspects from the other climatic regions in the country. Its climate is dominated by the onshore flow of Pacific airstreams which must ascend the mountainous continental shoreline. The peculiar climatic conditions of this region extend along a narrow coastal strip from the Aleutian Islands to the State of Washington. In a global perspective, the same climate occurs for similar reasons only in Chile, the South Island of New Zealand, in western Scotland and Norway (Hare & Thomas 1974). The Köppen-Geiger (1954) system of world climatology places the Queen Charlotte Islands into the "*Cfb*" category which essentially refers to a. . .

- mild humid climate with no dry season;

- precipitation regime where the driest month averages more than 3 cm;

- warm summer pattern where the average of the warmest month is below 22 degrees C.

It is noteworthy to mention that this particullar climate category is typical for less than 1 percent of the Canadian climate. It occurs only in the province of British Columbia, and then only within about 80 kilometres of the Pacific coastline (Williams 1968).

While the mountains of the Islands and particularly the mainland make their orographic effect felt by causing most of the moisture carried shoreward by easterly-trending storm systems to cool, condense and fall as rain or snow, they also provide some protection during the winter months from westward-trending incursions of cold Continental air of arctic origin. As a direct result of this, the Queen Charlotte Islands experience very mild winters and dry, sunny but very cool summers, and do not generally experience extreme annual temperature variations (Williams 1968). The primary stations selected to provide a climatological overview for the South Moresby/Gwaii Haanas National Park Reserve are Sandspit A, Sewell Inlet, Tasu Sound, and Cape St. James.

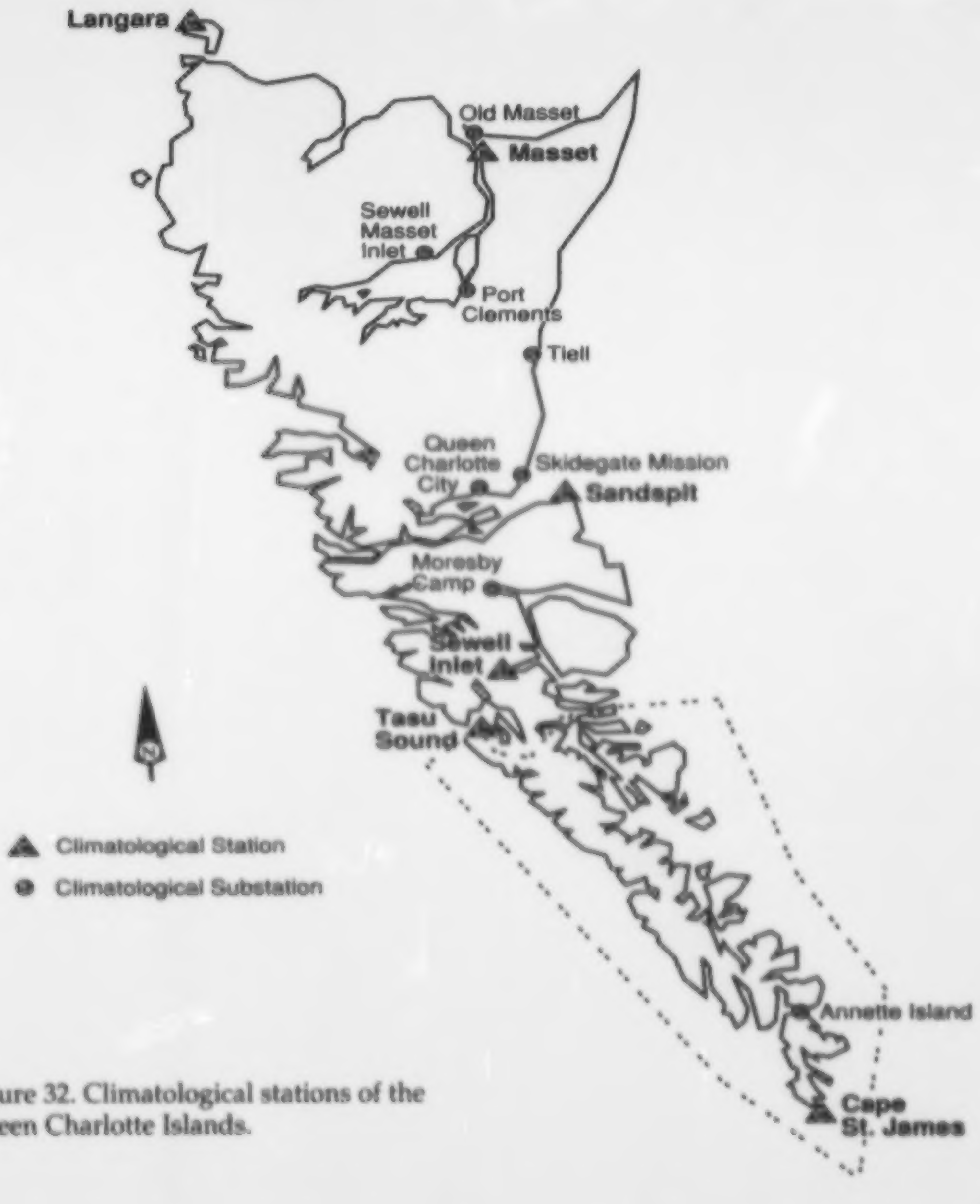

Langara
Old Masset
Masset
Sewell Masset Inlet
Port Clements
Tlell
Queen Charlotte City
Skidegate Mission
Sandspit
Moresby Camp
Sewell Inlet
Tasu Sound
Annette Island
Cape St. James
N
Climatological Station
Climatological Substation

Figure 32. Climatological stations of the Queen Charlotte Islands.

Climate Averages 1951-1980 (Anon. 1982)

Station:	Height a.s.l (m) :	Frost-Free Days:	Last Frost:	First Frost:
Sandspit A	5	206	Apr. 17	Nov. 10
Sewell Inlet	12	180	May 5	Nov. 2
Tasu Sound	15	217	Apr. 12	Nov. 16
Cape St. James	89	272	Apr. 25	Oct. 25

Climate Extremes 1951-1980 (Anon. 1982d)

	Last Frost (Spring)		First Frost (Fall)	
	Earliest	Latest	Earliest	Latest
Sandspit A	Mar. 9	May 16	Sept. 22	Dec. 5
Sewell Inlet	Apr. 18	May 25	Oct . 18	Nov. 13
Tasu Sound	Mar. 1	May 12	Oct. 24	Dec. 15
Cape St. James	Jan. 6	Apr. 25	Oct. 25	no Frost

Daily Temperature (C°) (Anon. 1982a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Sandspit A	2.0	3.5	3.9	6.0	8.7	11.6	14.0	14.7	12.9	9.0	5.5	3.4	**7.9**
Sewell Inlet	1.1	2.7	3.2	5.9	8.6	11.7	14.3	15.1	12.7	8.6	4.7	2.7	**7.6**
Tasu Sound	2.8	4.3	4.2	6.1	8.7	11.3	13.5	14.6	13.0	9.7	6.0	4.1	**8.2**
Cape St. James	3.9	4.8	4.9	6.5	8.7	10.6	12.7	13.8	12.9	9.9	6.9	5.0	**8.4**

Total Precipitation (mm) (Anon. 1982a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Sandspit A	144.0	113.2	99.6	84.4	52.2	51.7	43.2	49.5	89.9	194.4	180.9	178.0	**1281.0**
Sewell Inlet	461.8	415.1	338.5	309.5	195.2	124.5	108.0	119.5	308.4	671.3	536.5	580.2	**4168.5**
Tasu Sound	435.4	448.0	375.1	361.4	219.1	132.3	123.9	175.9	309.6	596.1	528.4	512.7	**4217.9**
Cape St. James	161.6	136.9	130.1	106.5	85.3	73.6	58.4	78.6	125.0	197.6	187.1	190.9	**1531.6**

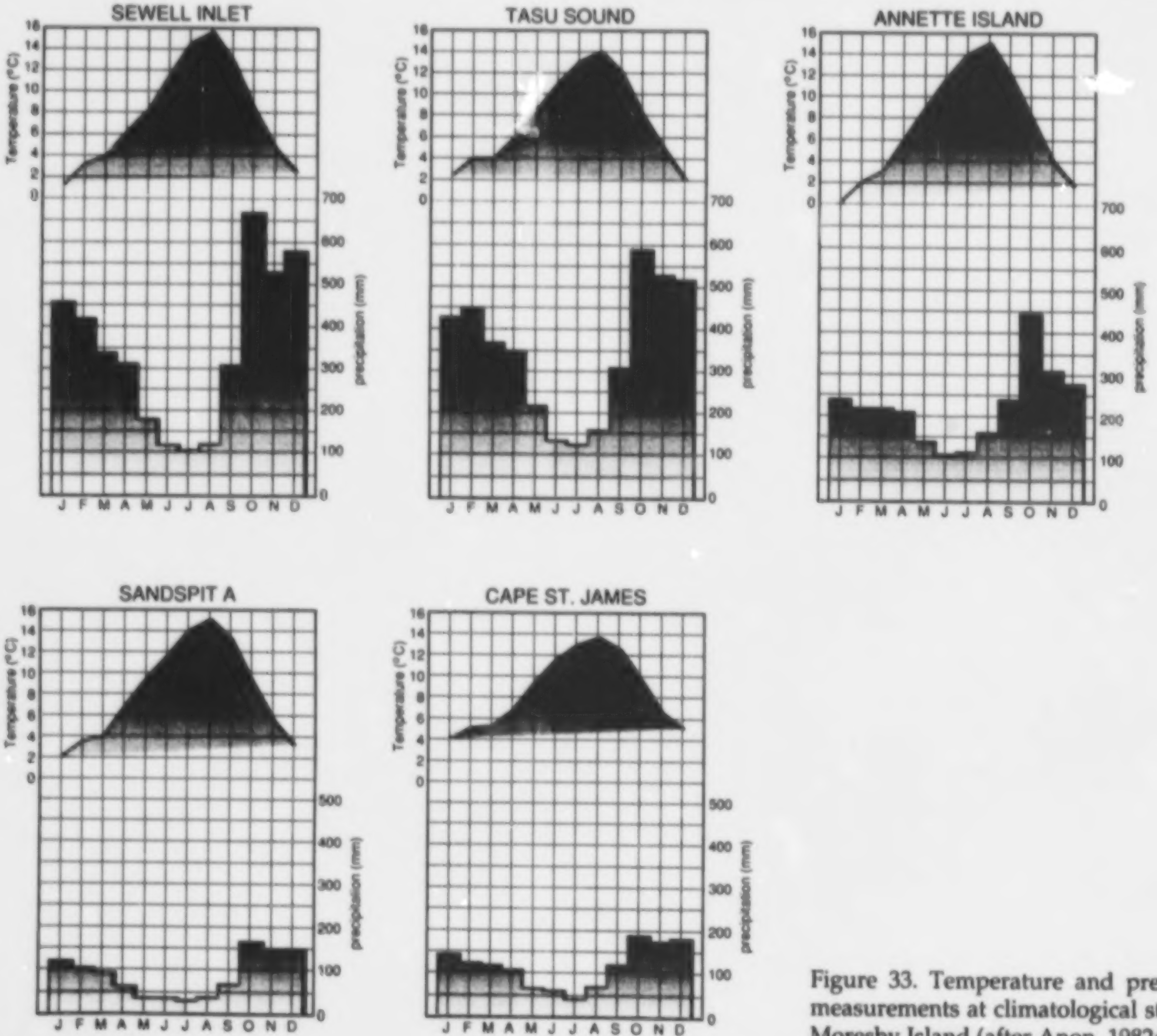


Figure 33. Temperature and precipitation measurements at climatological stations on Moresby Island (after Anon. 1982a)

Days with Precipitation (Anon. 1982a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Sandspit A	21	19	19	17	15	14	12	13	16	23	22	23	**214**
Sewell Inlet	19	20	21	19	16	14	13	13	18	24	22	23	**222**
Tasu Sound	21	20	23	19	16	15	13	13	18	25	23	23	**229**
Cape St. James	23	21	22	20	17	16	14	14	18	24	24	26	**239**

Of the total precipitation, the average snowfall amount for the whole of the Queen Charlotte Islands averages less than 762.0 mm. More specifically, Cape St. James receives less than 254.0 mm, Langara, Masset, Tlell, and Sandspit A receive between 508.0 and 762.0 mm, while Tasu Sound probably receives about 635.0 mm (Williams 1968).

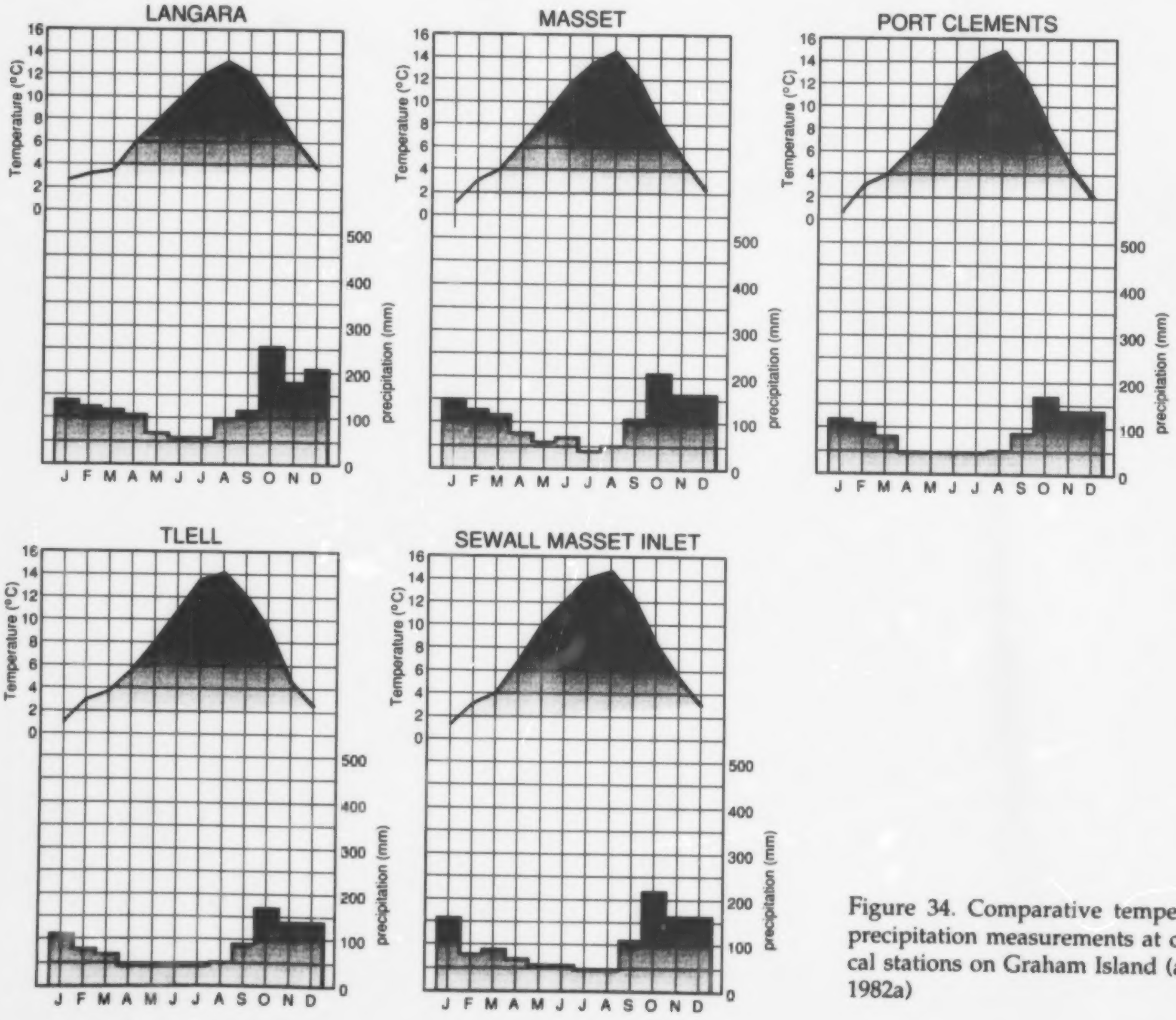


Figure 34. Comparative temperature and precipitation measurements at climatological stations on Graham Island (after Anon. 1982a)

A comparison between the climatic data collected at the the five stations serving Moresby Island and a similar number serving Graham Island (*i.e.*, Langara, Masset, Port Clements, Tlell and Sewall Masset Inlet) clearly shows the former receiving considerably more precipitation and marginally higher temperatures throughout the year (Anon. 1982a).

Consistent wind speed measurements taken at 10.1 metres above the ground are only available for the Sandspit A and Cape St. James climatological stations (Anon. 1982c). They indicate that calm conditions prevail between 8.1 (Dec.) and 13.3 (Aug.) percent of the time, while southeast winds occur most frequently between 16.1 (Aug.) and 22.7 (Oct.) percent of the time at Sandspit A. Mean wind speeds at the same station and considering all directions, range between 13.8 (Aug.) to 21.0 (Apr.) kilometres per hour, but maximum gusts have been recorded ranging from 87 km/h SE (Aug.) to 164 km/h SE (Feb.). By contrast, the Cape St. James station experiences calm conditions only from 0.3 to 1.3 percent of the time; northwest winds occur most frequently between 9.6 (Nov.) and 35.6 (July) percent of the time. Mean wind speeds at the Cape (all directions) range from 26.1 (Aug.) to 41.7 (Dec.) kilometres per hour, but maximum gusts have been recorded that ranged from 87 km/h NW (June) to 193 km/h SE (Feb.).

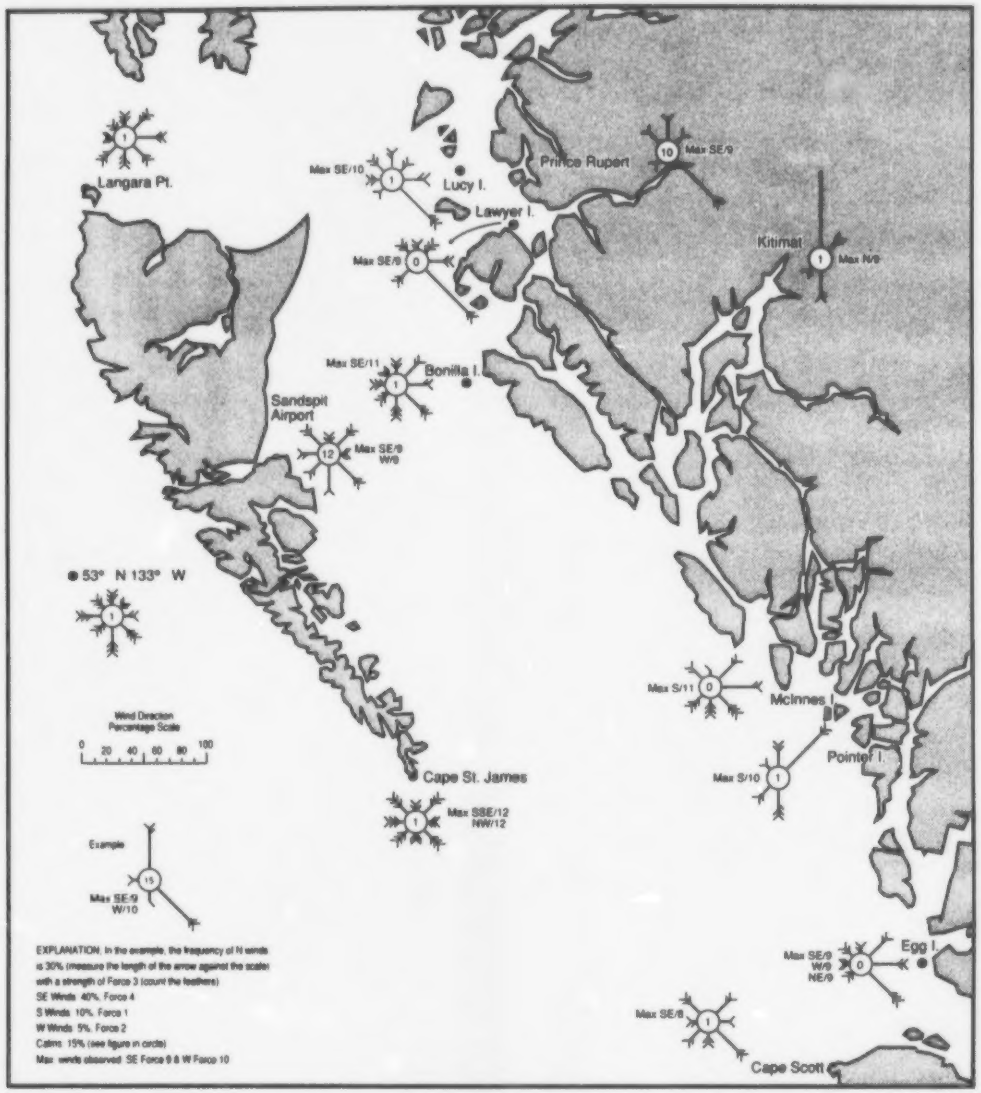

Langara Pt.
Max SE/10
Lucy I.
Lawyer I.
Prince Rupert
Max SE/9
Max SE/9
Kitimat
Max N/9
Max SE/11
Bonilla I.
Sandspit Airport
Max SE/9 W/9
● 53° N 133° W
Wind Direction Percentage Scale
0 20 40 60 80 100
Cape St. James
Max SSE/12 NW/12
Max S/11
McInnes I.
Pointer I.
Max S/10
Example
Max SE/9 W/10
Max SE/9 W/9 NE/9
Egg I.
Max SE/8
Cape Scott
EXPLANATION: In the example, the frequency of N winds is 30% (measure the length of the arrow against the scale) with a strength of Force 3 (count the feathers)
SE Winds 40%, Force 4
S Winds 10%, Force 1
W Winds 5%, Force 2
Calms 15% (see figure in circle)
Max winds observed SE Force 9 & W Force 10

Figure 35. Average direction and force (Beaufort scale) and maximum winds observed over 7 to 19 years for the month of January (after Anon. 1987b)

Notwithstanding the foregoing descriptions, the percentages of seasonal wind directions are as follows:

	SE	SW	W	NW
Winter	26	11	10	16
Spring	24	11	13	22
Summer	19	11	16	27
Fall	34	12	8	14

In addition, during periods of cold and clear winter conditions, cold air accumulations over the Interior Plateau of the mainland, retained there by the physical barrier of the Coast Range mountains, periodically and unpredictably invade most coastal inlets, including those along the west coast of the Queen Charlotte Islands. These very forceful winds are known as *"Squamish winds "*. They can reach wind speeds of between 92.6 and 138.9 (unsubstantiated) kilometres per hour and their gravitational flow towards sealevel is "accentuated by the orientation and narrowness of the major inlets" (Anon. 1987b). Their initiation is not believed to be triggered by cyclonic storm systems, but by a drop in atmospheric pressure in the offshore area.

Another set of similarly violent winds is peculiar to the inlets of the west coast of the Queen Charlotte Islands. They are refered to as the *"Williwaws "*. They occur mainly during the winter months, when they can cause dangerous marine conditions near the mouths of narrow inlets.

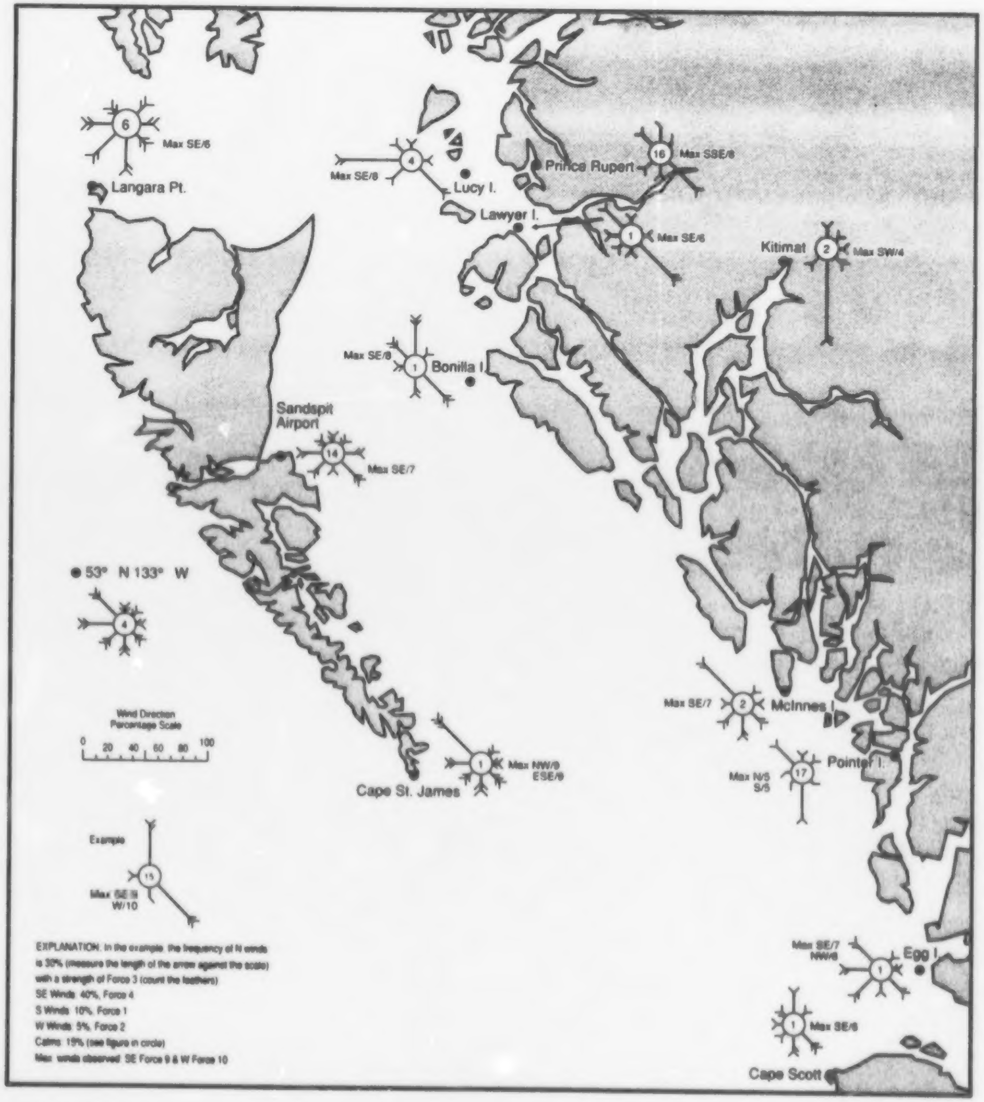

6
Max SE/6
Langara Pt.
4
Max SE/8
Lucy I.
Lawyer I.
Prince Rupert
16
Max SSE/8
1
Max SE/6
Kitimat
2
Max SW/4
Max SE/8
1
Bonilla I.
Sandspit Airport
14
Max SE/7
53° N 133° W
4
Wind Direction Percentage Scale
0 20 40 60 80 100
Max SE/7
2
McInnes I.
Max N/5 S/5
17
Pointer I.
1
Max NW/9 ESE/9
Cape St. James
Example
15
Max SE/9 W/10
EXPLANATION: In the example the frequency of N winds is 30% (measure the length of the arrow against the scale) with a strength of Force 3 (count the feathers)
SE Winds 40%, Force 4
S Winds 10%, Force 1
W Winds 5%, Force 2
Calms 15% (see figure in circle)
Max winds observed SE Force 9 & W Force 10
Max SE/7 NW/6
1
Egg I.
1
Max SE/6
Cape Scott

Figure 36. Average direction and force (Beaufort scale) and maximum winds observed over 7 to 19 years for the month of July (afterAnon. 1987b)

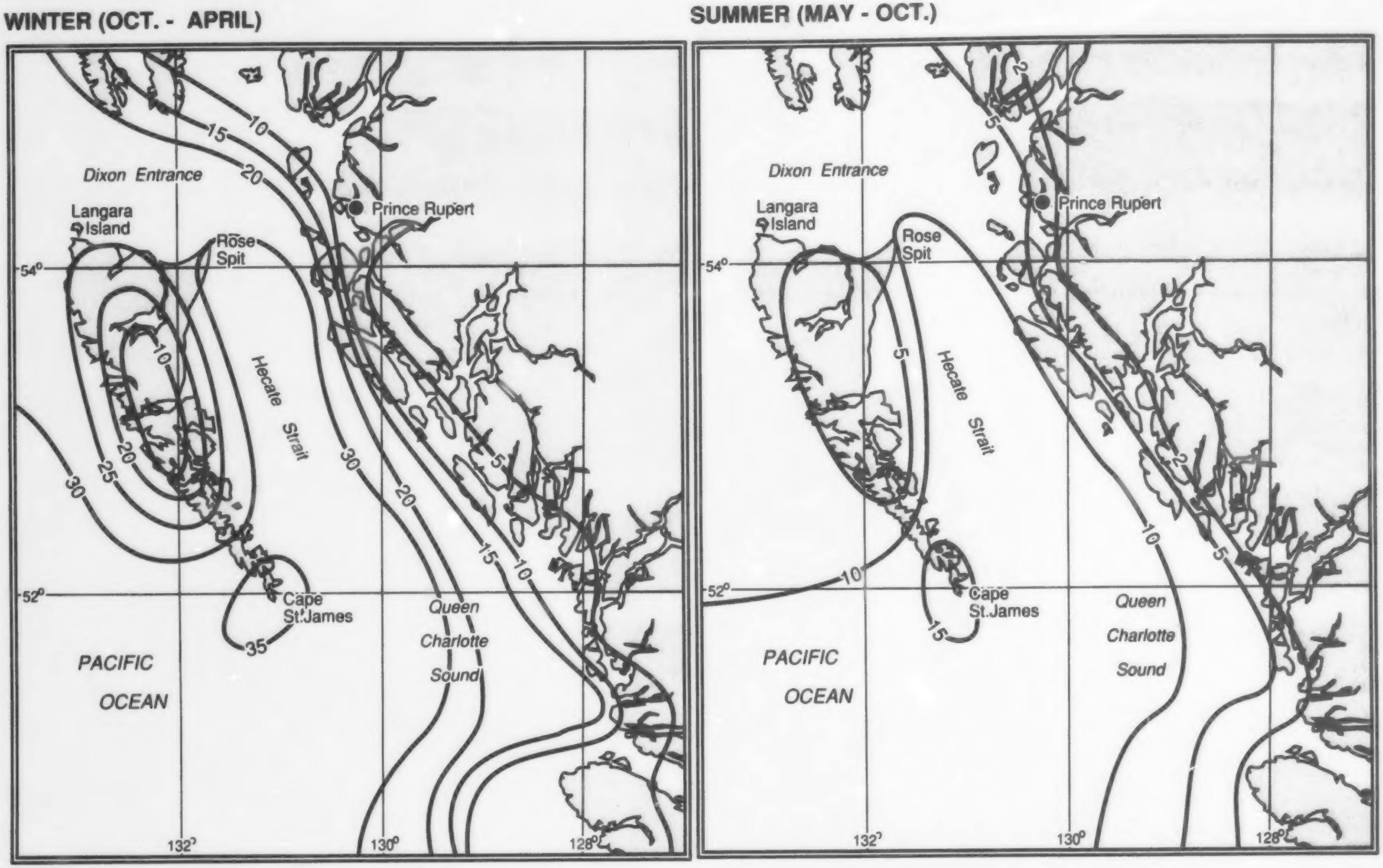

WINTER (OCT. - APRIL)
SUMMER (MAY - OCT.)
Dixon Entrance
Langara Island
Rose Spit
Prince Rupert
Hecate Strait
Cape St.James
Queen Charlotte Sound
PACIFIC OCEAN
54°
52°
132°
130°
128°
5
10
15
20
25
30
35
2

Figure 37. Percent frequency of winds greater than or equal to 40 km/hr (after Faulkner & Schaefer 1978; Anon. 1982c.)

Because it has long been understood that, along with moisture, plants and other organisms require optimum temperature to achieve maximum growth, the Canadian Climate Normals (Anon. 1982b) have for years now compared various departures from the daily mean temperature with some stated reference temperature and expressed the results as "degree days". These measurements find their greatest application in the pursuit of agriculture, but could be used as an expression of potential forest productivity as well. The following calculations have been abstracted from the available temperature data for Moresby Island:

Degree-Days above 10.0 Degrees C., 1951-1980 (Anon. 1982b).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Sandspit A	0.0	0.0	0.0	0.6	9.5	51.4	124.2	147.2	88.7	15.0	0.7	0.0	437.3
Sewell Inlet	0.0	0.0	0.0	3.0	15.3	56.7	132.6	158.0	83.2	15.4	0.5	0.0	464.7
Tasu Sound	0.0	0.1	0.1	1.5	13.8	46.6	110.7	142.8	91.9	27.2	3.8	0.2	438.7
Cape St. James	0.0	0.0	0.5	0.8	5.6	27.1	84.6	119.5	86.2	18.7	0.8	0.0	343.8

Temperature, precipitation, wind and sunshine data have been used in British Columbia to develop criteria for assessing the suitability of the prevailing climate for recreation purposes at individual locations (Bennett 1977). Obviously, the Atmospheric Environment Service stations, where the specific measurements were taken, are the locations to which Bennett (1977) applied his suitability rating scheme. In the case of the Moresby Island, only Sandspit A and Cape St. James climate stations were rated for "land-active" and "land-passive" suitabilities; meaning...

Land-active =
alpine skiing, bicycling, cross-country skiing, fishing, hiking, snowshoeing, snow mobiling, skating, team sports, tennis, tobogganing.

Land-passive =
walking, gardening , picnicking, family camping, beach use, golf, visiting outdoor sites of special interest (zoos).

Climate Suitability for Recreation

Climate Station:	Climate Factor:	Season:	Rating:
Sandspit A:	Sunshine	Summer (June-August)	mod. suitable
		Transition (Apr.-May, Sept.-Oct.)	mod. suitable
		Winter (Dec.-Feb.)	unsuitable
	Wind	Summer	unsuitable
		Transition	unsuitable
		Winter	mod. suitable
	Precipitation	Summer	mod. suitable
		Transition	unsuitable
		Winter	unsuitable
	Temperature	Summer	suitable (too cold)
		Transition	mod. suitable (too cold)
		Winter	unsuitable (too warm)
Cape St. James	Sunshine	Summer	no data
		Transition	no data
		Winter	no data
	Wind	Summer	least suitable
		Transition	least suitable
		Winter	unsuitable
	Precipitation	Summer	unsuitable
		Transition	least suitable
		Winter	unsuitable
	Temperature	Summer	mod. suitable (too cold)
		Transition	unsuitable (too cold)
		Winter	unsuitable (too warm)

Please note that: (1) Bennett (1977) did not consider the months of March and November to be periods where the recreation activities cited by him were practiced.
(2) The expressions "too warm" and "too cold" were used by Bennett as statements of secondary limiting factors.

a) RESOURCE ANALYSIS

It is clear from the description of what is currently known about the terrestrial climate of the Queen Charlotte Islands that they experience very cool summers, very mild winters, and there is a predominance of strong windy conditions, low cloud cover, and an abundance of late autumn and early winter rainfall, particularly on the west side of the Islands and during the month of October. Even though day lengths are usually long during the growing season, the periods and durations of bright sunshine are the lowest in Canada (Williams 1968). The main weather hazards related to recreation activities and public safety are (Anon. 1987b):

- the strong and variable winds associated with highly mobile, cyclonic storm systems;
- the periodic but severe Squamish and Williwaw winds during the winter months, and . . .
- the often extensive banks of dense sea fog that invade the land during the summer months.

It should come as no surprise, then, that the recreation suitability criteria developed by Bennett (1977), when applied to what is known climatically about the South Moresby/Gwaii Haanas National Park Reserve, do not give it a high rating within the context of the recreation suitability of British Columbia as a whole.

What is now known about the climate of the Pacific coast where this national park reserve is situated leaves no doubt about the fact that it is unique within Canada. The year-round, moderate temperatures, the very high rainfall regime, and the lack of severe winters provide this part of the west coast with the most lush and highly productive vegetation growth and general biological diversity known to occur anywhere in the country. Even the seasonal contrast is different. While in most other regions of Canada seasons are either very cold or warm and humid, along the west coast the seasonal change is one of mild but dreary and wet winters being replaced by relatively dry but cool, bright, summer months. Only the mountainous areas experience prolonged snow covers and frost annually; yet, on the Queen Charlotte Islands these conditions have not led to the formation and maintenance of recent glaciers.

However, this apparently benign climate is by no means without its own types of severity and danger to human activities. From late September to the end of April, frequent intervals of cyclonic storms invade the British Columbia portion of the Pacific coast. They are usually accompanied by strong winds, and are supplemented during colder periods by the influx of the occasional but severe Squamish and Williwaw winds. Prolonged, low cloud covers and seafogs add their own form of hazard to land, sea, and air travel and navigation.

Bennett (1977) and others have shown the climate of the Queen Charlotte Islands to be far less suitable to certain select visitor activities than one would surmise from the general mildness of the climate. At the very least, many of the visitor activities practiced under mainland weather conditions, as for example family camping, backpacking, and even hiking, will have to be severely modified to meet desirable comfort and safety levels in the face of the very different and often demanding west coast weather conditions. This is certainly not meant to infer that the range of recreational activities and opportunities is out of necessity restrictive. But it does imply that park managers and potential recreationists must either already be endowed with or be willing to develop mind-sets that are very conscious of the imposed climatic limitations, so that collectively they be able to set the stage for rereational pursuits to become worthwhile and enjoyable.

The high degree of climatic variability would seem to require an expanded net of climatic stations in order to monitor and record the high degree of climatic diversity and severity within the relatively small landmass of the Queen Charlotte Islands. In fact, while quite a number of intermittantly-operated climate station have gathered a variety of weather data over the years, only six climate stations operated by the federal Atmospheric Environment Service are currently gathering data in the area. These stations are all located at sealevel, and coastline or inland locations. There is presently no coordinated system in place capable of monitoring and recording the full range of horizontal and vertical climatic conditions.

Management Concerns

The oceanic position of the Queen Charlotte Islands within the surrounding maritime region make it imperative that any park manager of the South Moresby/Gwaii Haanas National Park Reserve become conversant with and knowledgeable about the full range of climatic conditions that have the potential to affect park management programs, visitor activities, and public safety. Every human activity and enterprise on the Islands is in a significant way affected by the peculiar prevailing climate in association with the close proximity of the Pacific Ocean. It is important to note that this statement includes every aspect of the park management program to a greater or lesser degree.

The absence of a coordinated and fully-automated, climate monitoring system within the park reserve, capable of providing constant "real time" interaction with park managers, is a situation that does not facilitate the effective application of mandated park programs, like public communication, park interpretation, law enforcement, public safety and rescue. Not to be able to have "real time" weather information available during operational decision-making activities, is tantamount to taking potentially costly chances with lives, facilities and materials.

The costs associated with the installation of the type of climate monitoring system discussed here will be outweighed by the expected improvement in the image of the Canadian Parks Service as perceived locally, by the betterment of facility management, by an increase in operational efficiency, and quite possibly by a reduction in potentially embarrassing land and sea tragedies. Also, the installation of such a system may be negotiated through cooperative efforts with the federal Atmospheric Environment Service and in association with the Canadian Hydrographic Service.

Status of Knowledge

The present status of knowledge about the prevailing climate of the Queen Charlotte Islands covers at best only a broad level of understanding of the hemispheric and regional climate patterns. There is only a very limited level of understanding of the meso-climate of the South Moresby/Gwaii Haanas National Park Reserve, and with perhaps the exception of the few climate stations known to be operative, there is no coverage of the micro-climatic data at all.

The reason(s) for the known data gaps has already been alluded to, as have ways to overcome the present shortcomings within the available data base. In addition, the establishment of representative upland and inland climate stations needs to be considered to provide data as a requisite for "ecologically sound" park planning and resource management.

b. SELECT REFERENCES

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B. MARINE CLIMATE

While atmospheric climate in the immediate coastal region is treated as an inseparable part of the terrestrial weather pattern, there exists above and within the semi-exposed and outer ocean a counterpart to terrestrial climate in terms of air and sea surface temperatures, barometric pressure, and wind conditions which can be described as marine climate. The delineation between atmosphere and ocean is, however, somewhat artificial in that the interaction between the two is constant with respect to climate. Not only does the hydrologic cycle link ocean and atmosphere, but wind affects ocean currents, upwelling, and general circulation, just as currents supply energy which helps to propel atmospheric circulation. Additionally, the air and the ocean have the ability to react to produce icing conditions, reduce visibility and cause low ceilings over the ocean. The most important climatic distinction between the ocean and the land is in the greater heat storage capacity of the ocean which ameliorates the extremes of the terrestrial climate.

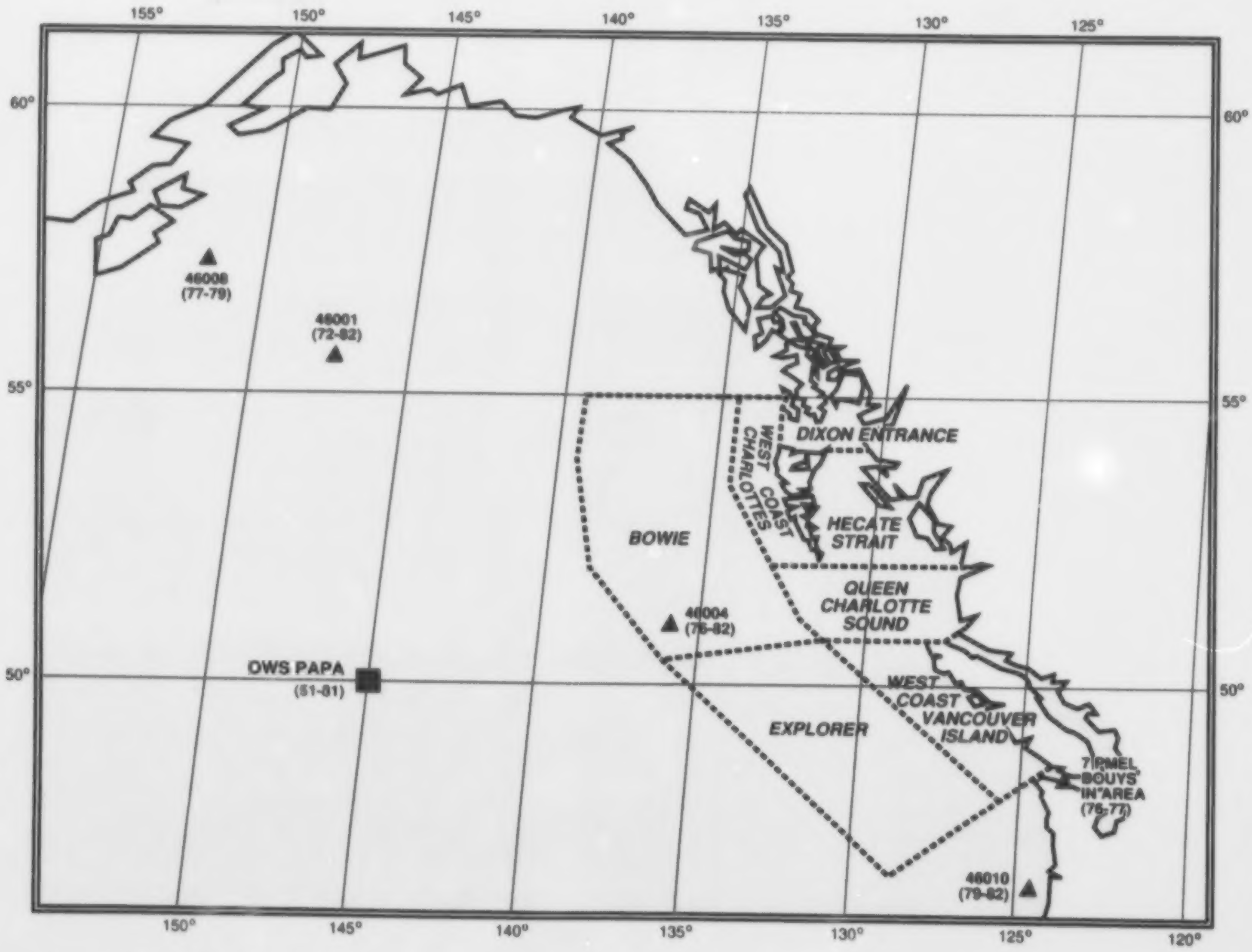
Climate History

The earliest marine climatological data for British Columbia are those gathered by ships of opportunity (national and international vessels which cooperate to provide both climatological and oceanographic information as the opportunity presents itself) on air temperature, sea surface temperature, wind and visibility as early as 1857 (Brown *et al.* 1986). The British Columbia Shorestation Oceanographic Programme (BCSOP) began in 1914 with surface seawater temperature and density recordings at what is now the Pacific Marine Biological Station of the Department of Fisheries and Oceans in Departure Bay, Vancouver Island. But lighthouse stations in the Queen Charlotte Islands region did not begin record keeping until later: Bonilla Island, 1927; McInnes Island, 1933; Cape St. James, 1947: Langara Island, 1948 (Giovando 1988).

As the history of oceanographic data gathering is a relatively recent one, all of our records are "modern". But it is possible to speculate on early oceanic conditions based on what we know of the geologic history of the earth. Following the birth of the solar system some 4.5 billion years ago, the earth cooled gradually, reaching a point around 3.7 to 2.2 billion years ago when the cooling was sufficient to allow most of the water squeezed out of the solids forming the earth to condense into a vast ocean much warmer though only slightly less saline than the one we know today (Thomson 1981). Subsequent regional plate tectonic movement beginning about 200 million years ago, and glaciations over four periods, beginning about 1-2 million years ago and ending about 10,000 years ago, have served to define the present shores of British Columbia upon which the sea continues its slow eustatic rise.

Modern Climate

Our knowledge of marine meterological and oceanographic data relies mostly on the observations of ships of opportunity and Ocean Weather Station Papa (at 50° N 145° W, operational from 1951 to 1981), as well as those of automatic weather buoys positioned at various locations in the northern Pacific Ocean. Though such information is sporadic, it affords a good measure of relative changes in weather patterns.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46008
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OWS PAPA
(51-81)
46004
(76-82)
46010
(79-82)
BOWIE
WEST COAST CHARLOTTES
DIXON ENTRANCE
HECATE STRAIT
QUEEN CHARLOTTE SOUND
WEST COAST VANCOUVER ISLAND
EXPLORER
7 PMEL BOUYS' IN AREA (76-77)

Figure 38. Location of marine forecast areas, OWS PAPA and main automatic weather bouys (after Brown et al. 1986)

While the orographic effect of the land mass is clearly a dominating factor in determining nearshore aspects of weather, latitude makes an obvious difference in some respects. This is nowhere clearer than in the case of air temperature, which in the Bowie Marine Forecast Area has shown a January monthly mean of 5.5° C. and a July monthly mean of 12.8 C. over the 1901 to 1985 period (Brown 1987). The seasonal range in temperatures is far less dramatic than over the Continental land mass which lacks the dampening effect provided by the oceanic heat sink.

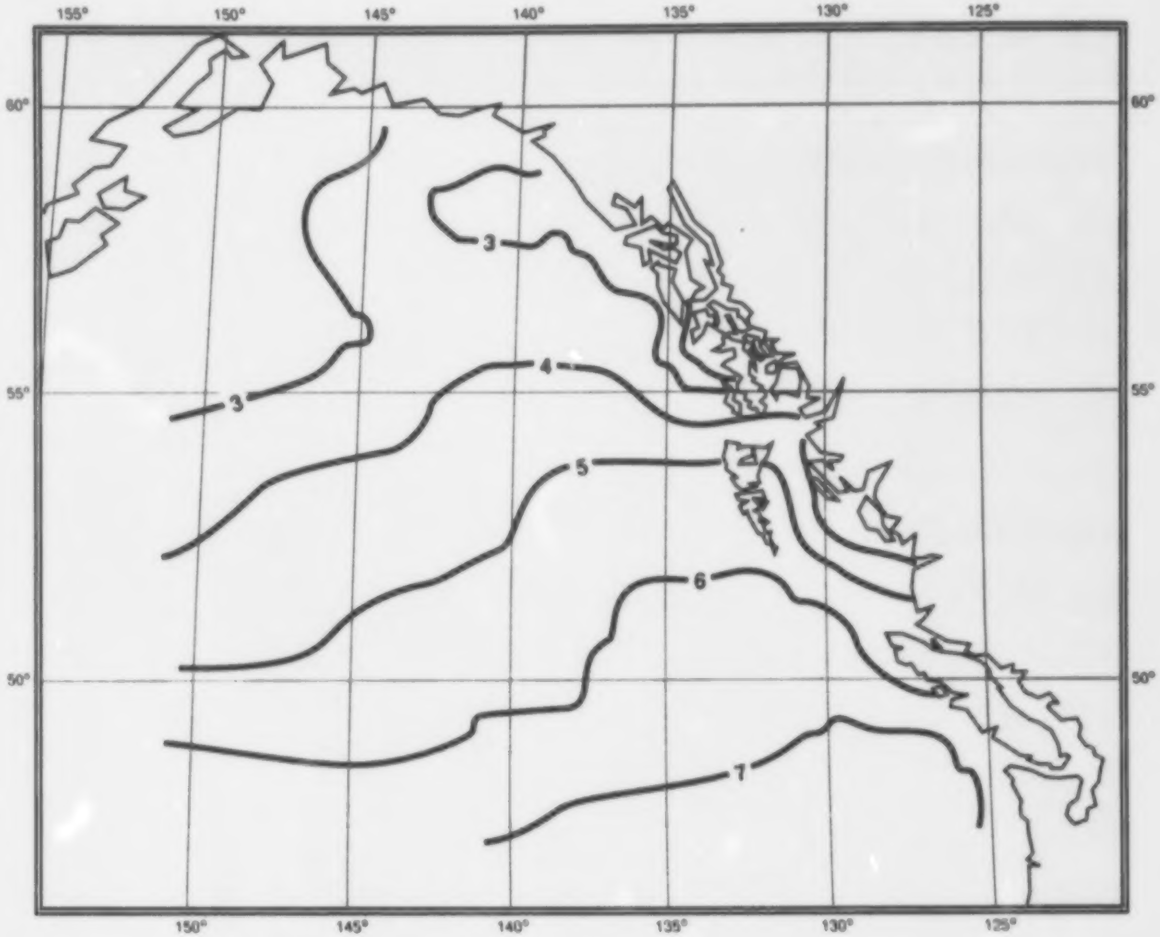
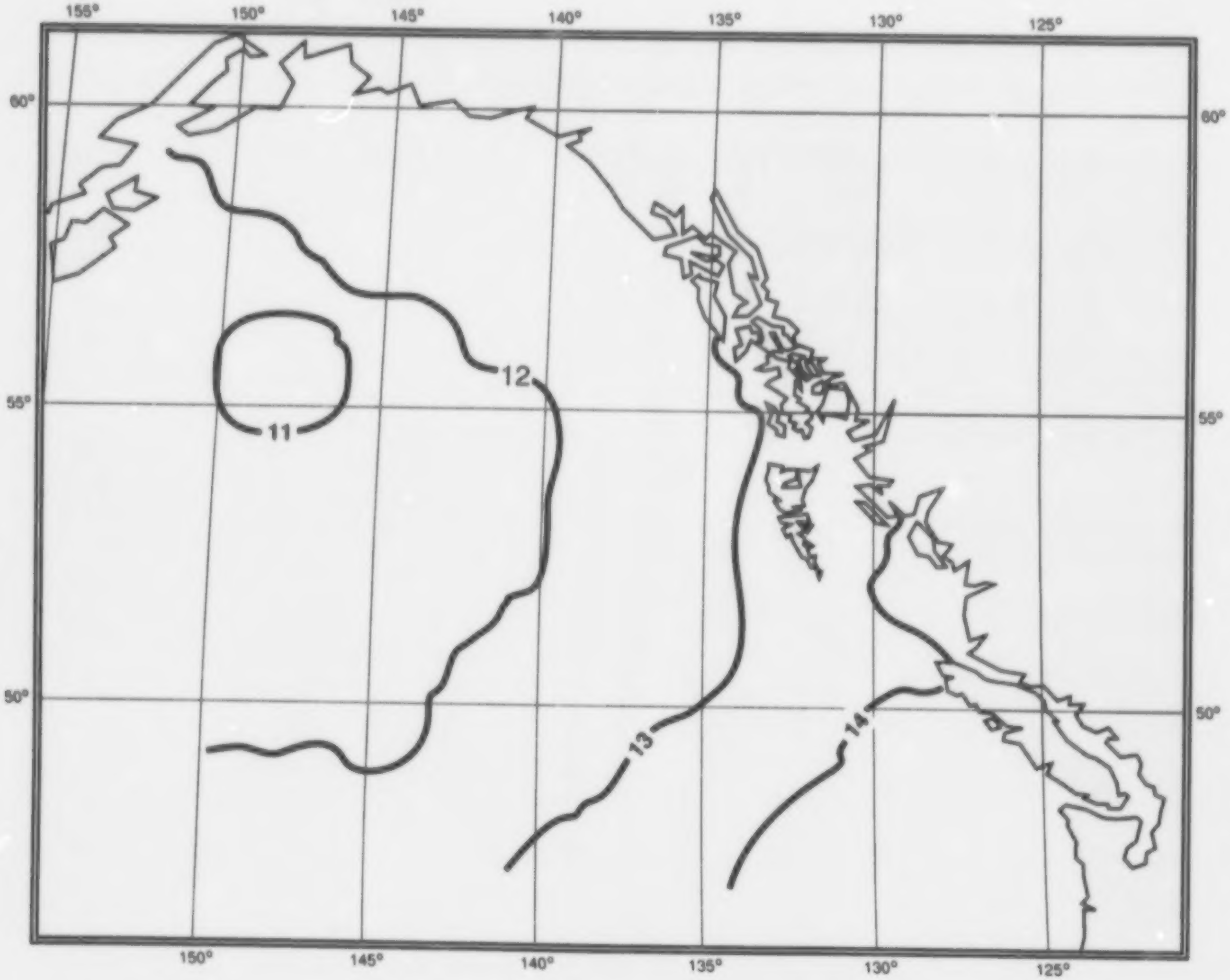


Figure 39. January air temperature. Lines indicate mean (1857-1985) temperature in degrees C. (after Brown et al. 1986)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14

Figure 40. July air temperature. Lines indicate mean (1857-1985) temperature in degrees C. (after Brown et al. 1986)

Sea surface temperature along the British Columbia coast is normally increased only in correspondence with an El Niño Southern Oscillation Episode, as was the case in 1925, 1941, 1957 and 1982. The exception was with the strong El Niño of 1972-1973, when the waters off the British Columbia coast cooled, though the temperature was warmer in 1973 than in 1972 (Thomson *et al.* 1984). Sea surface temperatures off the coast reach about 7° C. in January and about 12° C. in July. While the range in temperatures is not broad, neither does the water become warm enough to admit of activities such as swimming or SCUBA diving without the aid of insulation.

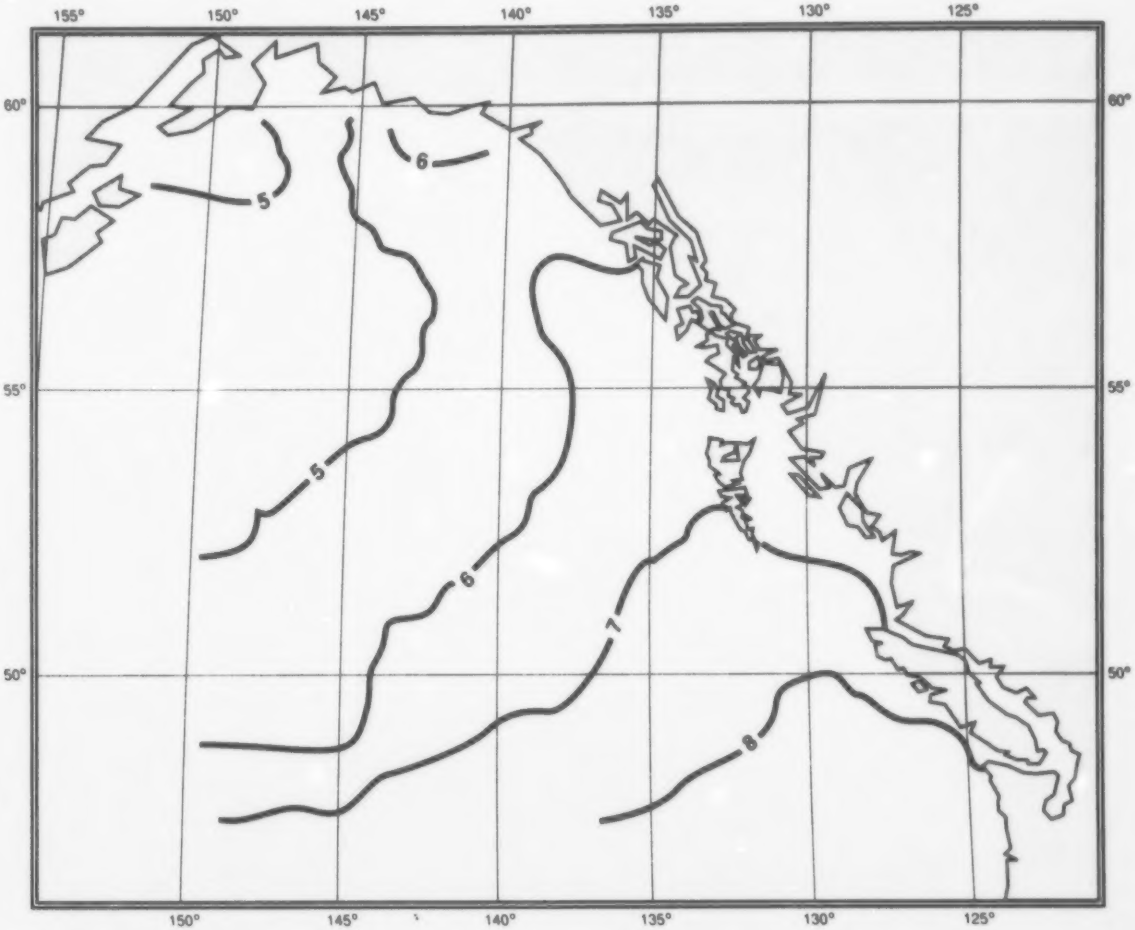

Figure 41. January sea surface temperature. Lines indicate mean (1857-1985) temperature in degrees C. (after Brown et al. 1986)

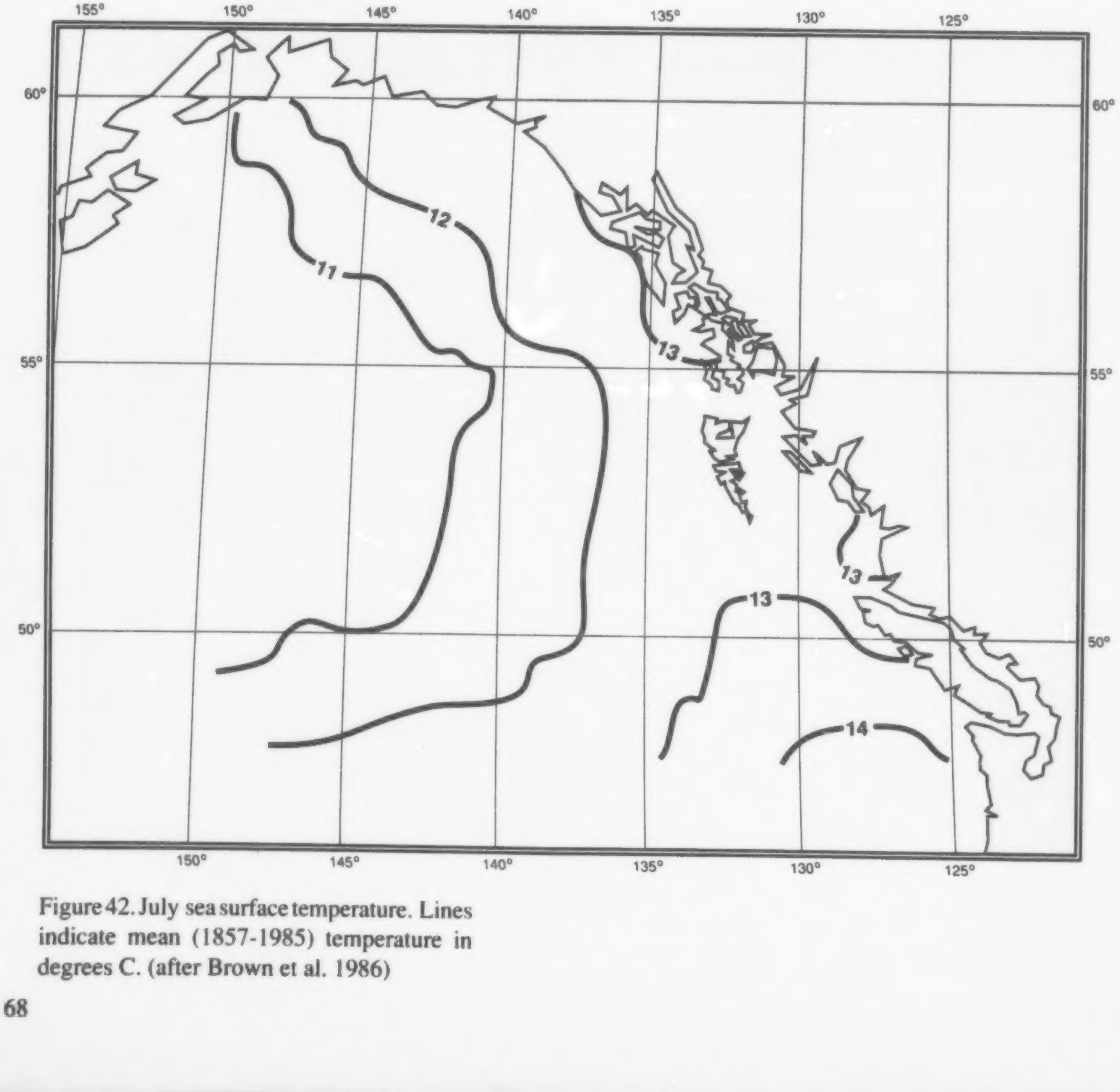
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Figure 42. July sea surface temperature. Lines indicate mean (1857-1985) temperature in degrees C. (after Brown et al. 1986)

Sea level pressures are more varied in the winter than in the summer over offshore British Columbia, but this is to be expected given the stormy winter weather. The fluctuations in pressure are more pronounced at sea than they are closer to the coast.

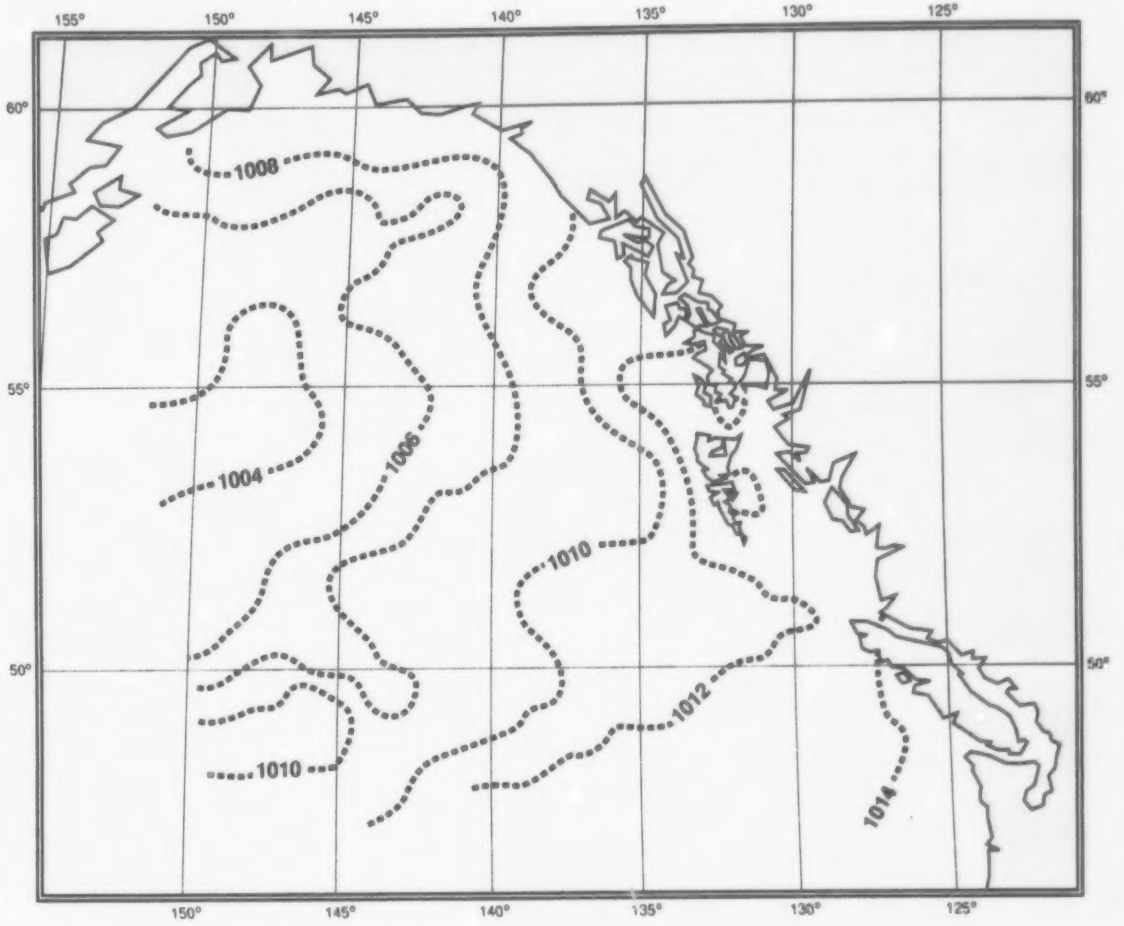
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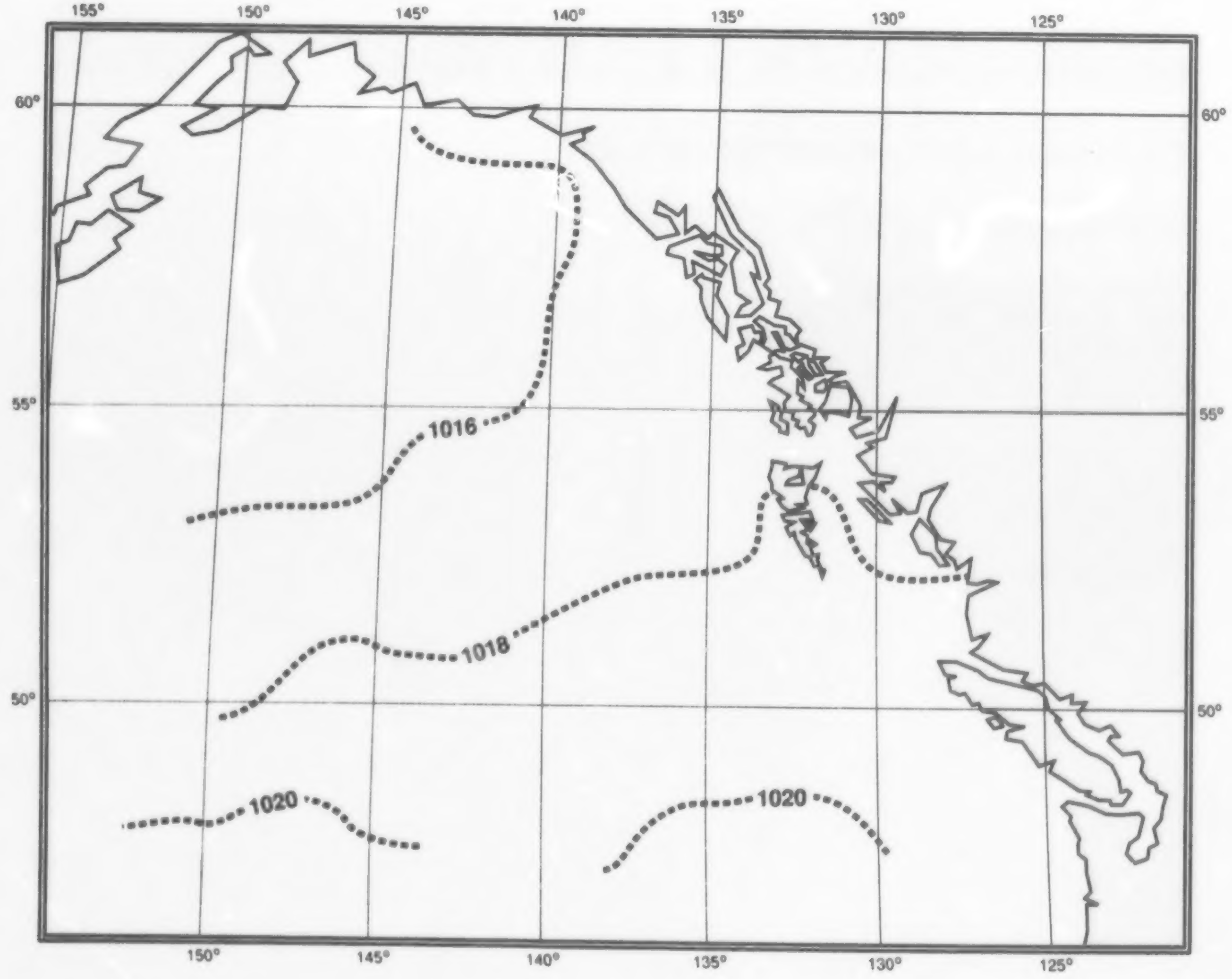
Figure 43. January sea level pressure. Lines indicate mean (1884-1985) pressure (MB) (after Brown et al. 1986)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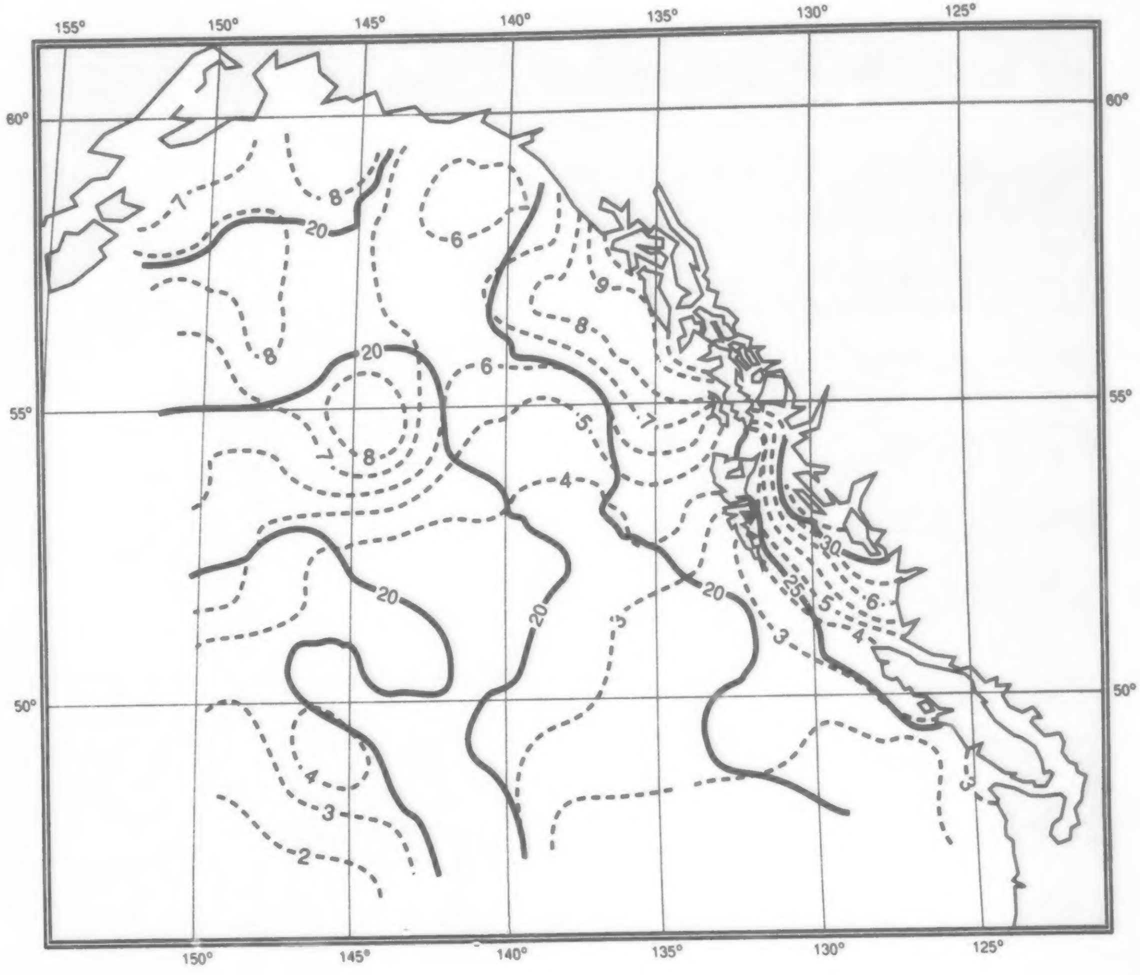
1016
1018
1020
1020

Figure 44. July sea level pressure. Lines indicate mean (1884-1985) pressure (MB) (after Brown et al. 1986)

The Queen Charlotte Islands themselves are described herein as having a mild, humid climate with no dry season. The same is true for the marine environment. The relative humidity hovers in the region of 85 percent year-round, while mean frequency of precipitation is as high as 15 percent even in July (Brown *et al.* 1986). Temperatures in the winter are warm enough that little of the January pecipitation is in the form of snow.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4
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30
25
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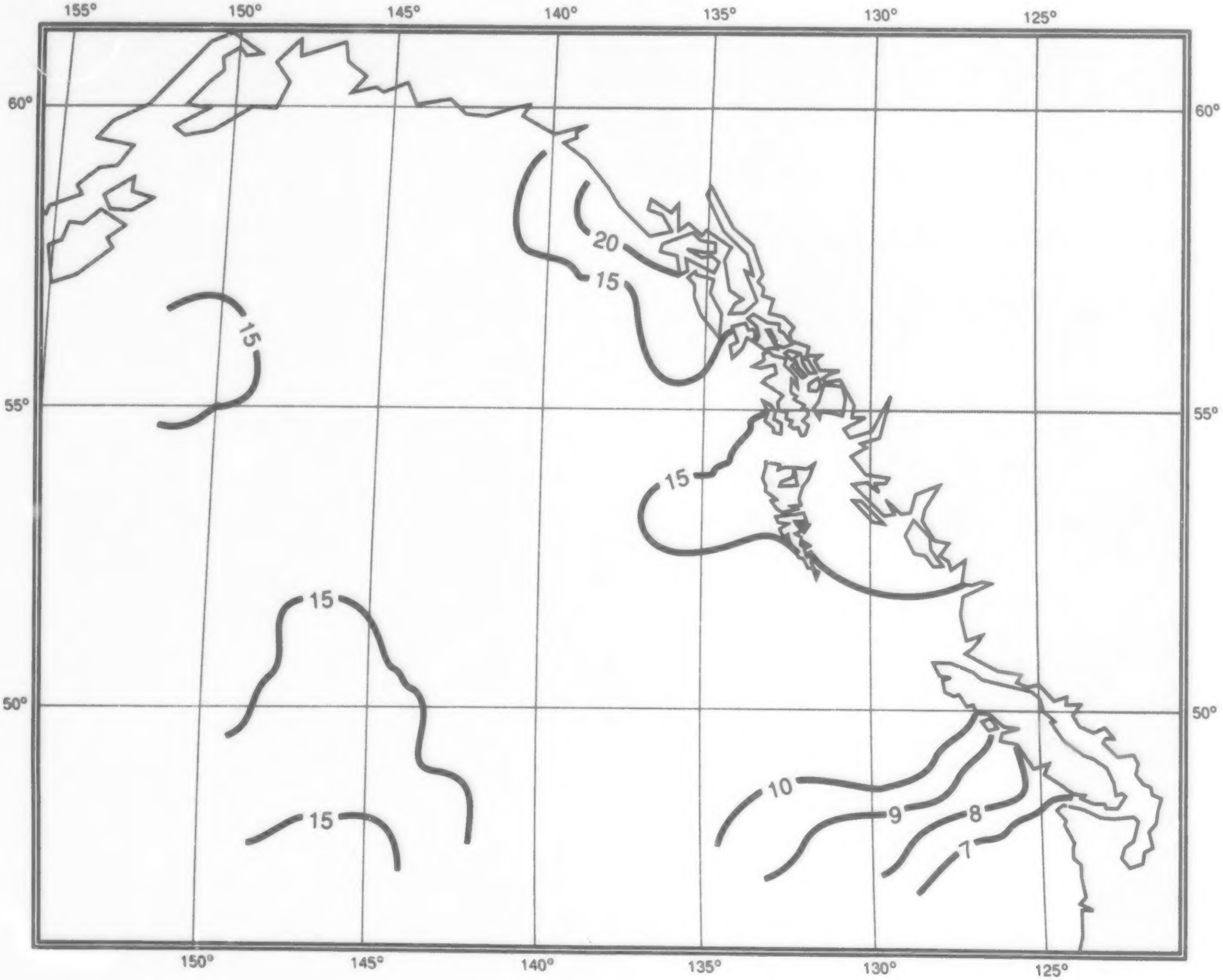
3
3
4
3
2

Figure 45. January precipitation. Heavy lines indicate percent frequency (1857-1985) of precipitation and thinner lines indicate percent frequency of snow (after Brown et al. 1986)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9
8
7

Figure 46. July precipitation. Lines indicate percent frequency (1857-1985) of precipitation (after Brown et al. 1986)

Of all weather factors which have serious implications for the travel in and enjoyment of the marine component of the South Moresby/Gwaii Haanas National Park Reserve, wind is perhaps the most important. Shifting from S-SE in January to NW in July, the offshore winds rise to a mean speed of little more than 20 knots (Brown 1987). But the winds can rise above gale force for 40 hours or more per month, particularly so in the winter months (Brown *et al.* 1986).

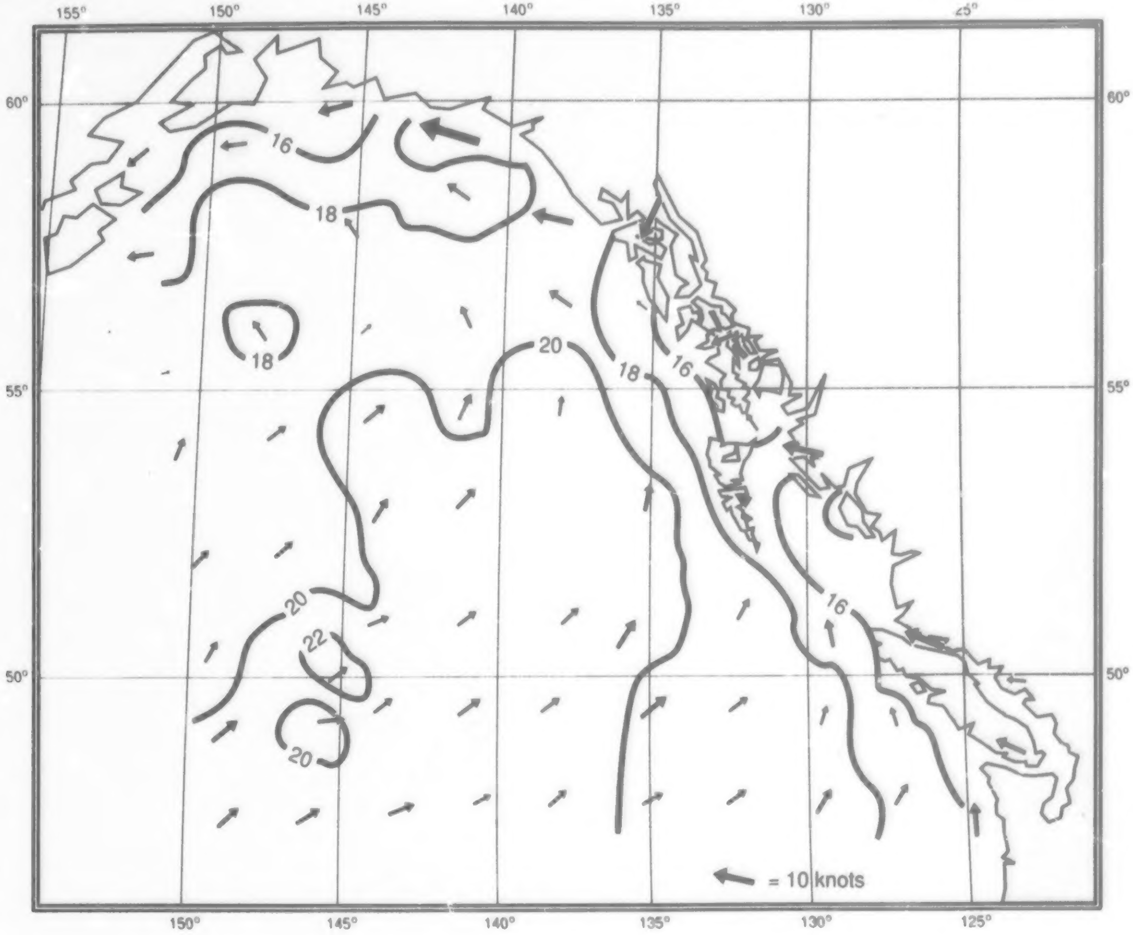
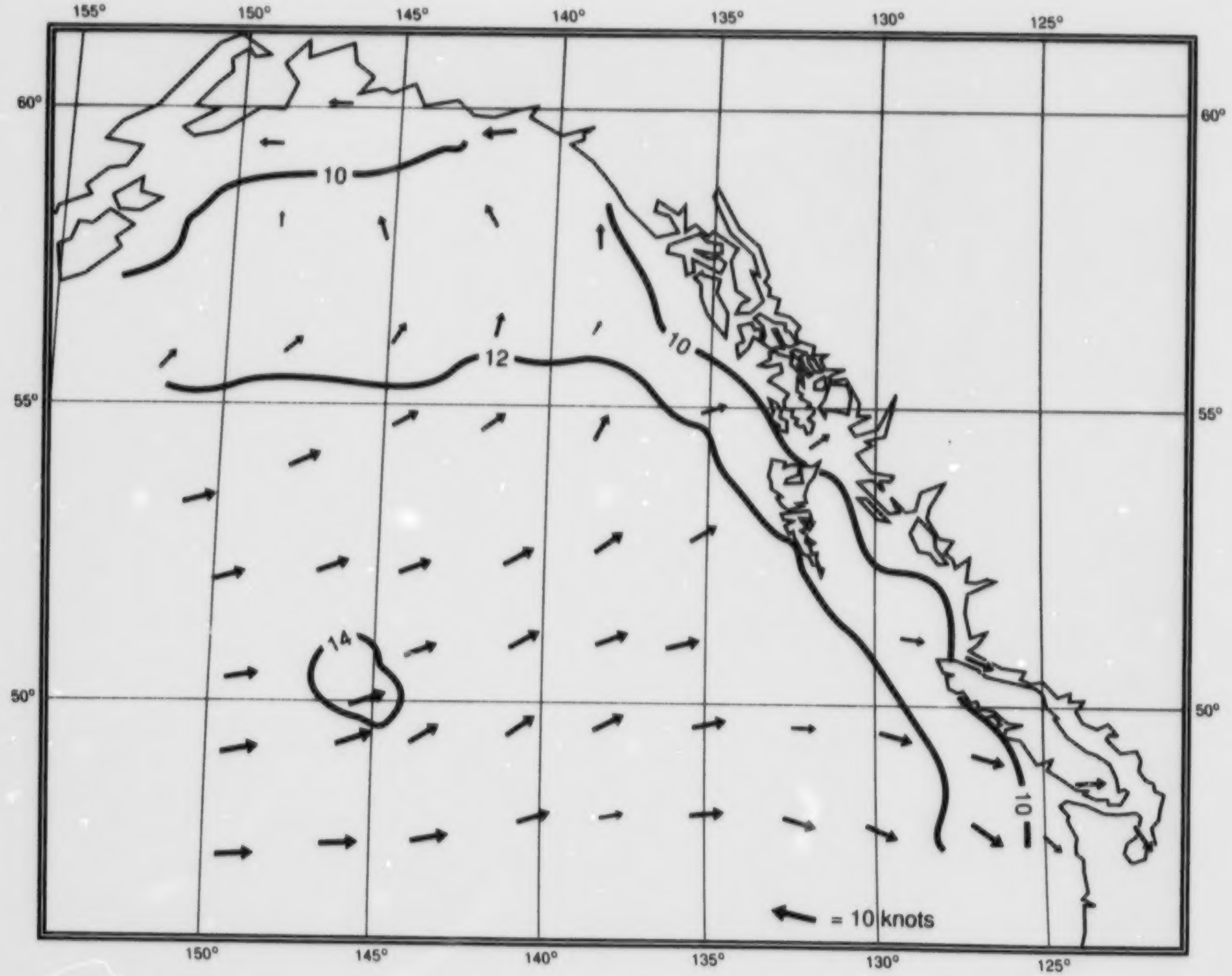


Figure 47. January wind direction and speed. Arrows are mean vector velocity (1857-1985), and lines indicate mean (1857-1985) speed in knots (after Brown et al. 1986)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60°
55°
50°
10
12
10
14
10
= 10 knots

Figure 48. July wind direction and speed. Arrows are vector mean velocity (1857-1985) and lines indicate mean (1857-1985) speed in knots (after Brown et al. 1986)

It is not merely the wind alone which acts as a determining factor of marine travel and enjoyment off the Queen Charlotte Islands. Roughness of the seas, as determined by the combined wave height, is significant as well. That the wind is a large contributor to wave height is evidenced by the fact that low levels of combined wave height; i.e. 2 metres or less in height, are more frequently experienced in July than in January.

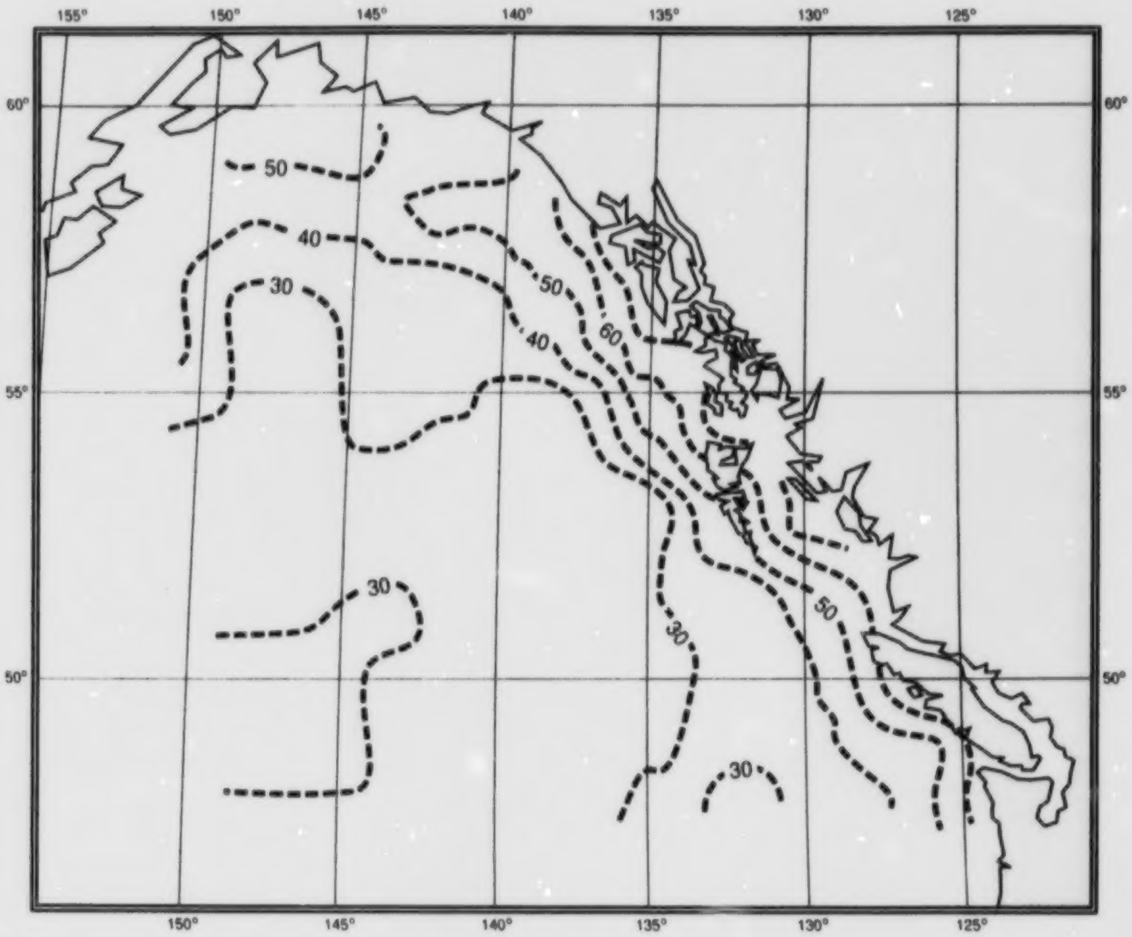
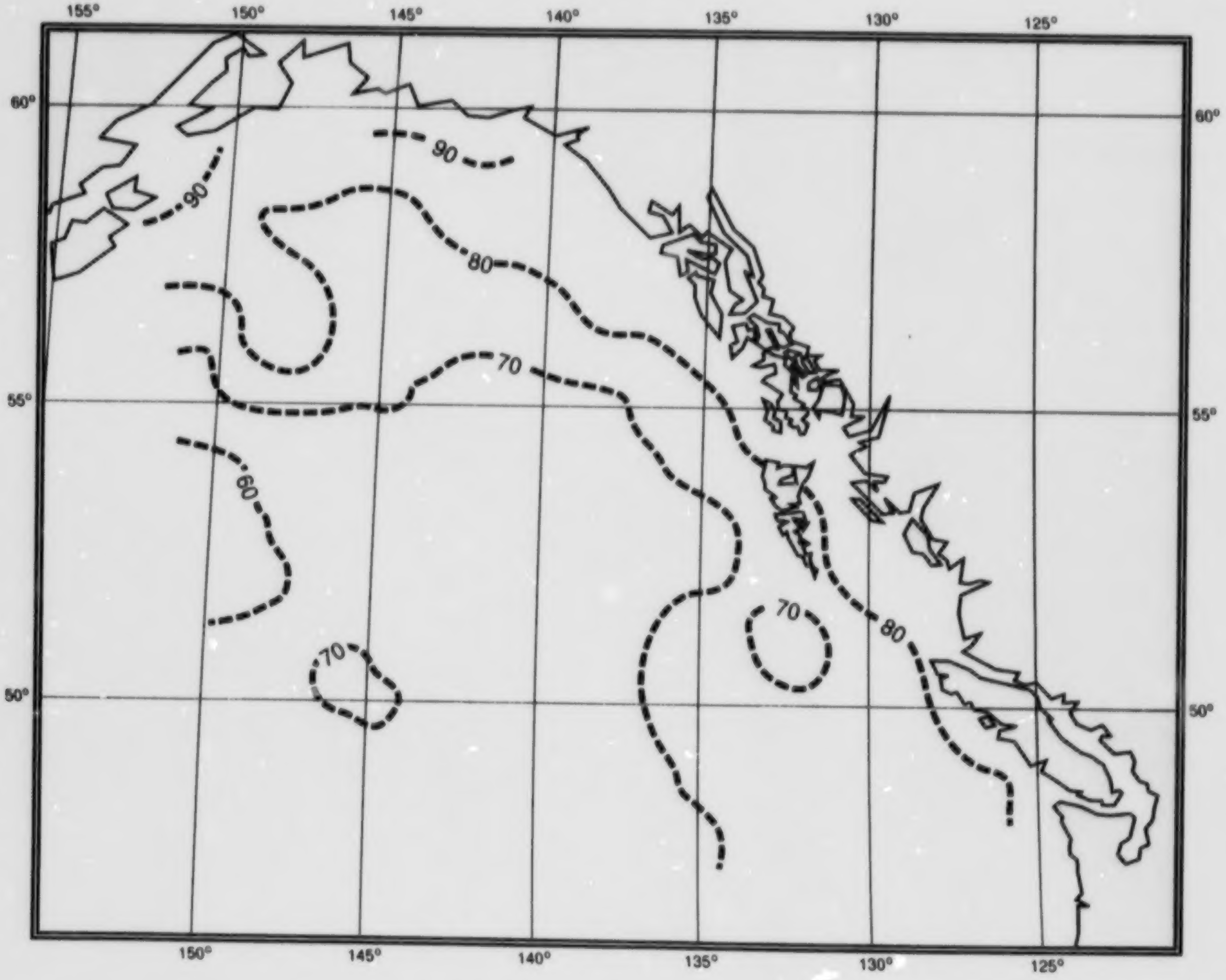


Figure 49. January wave height. Lines indicate percent frequency <= 2 meters (1949-1985) (after Brown et al. 1986)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60

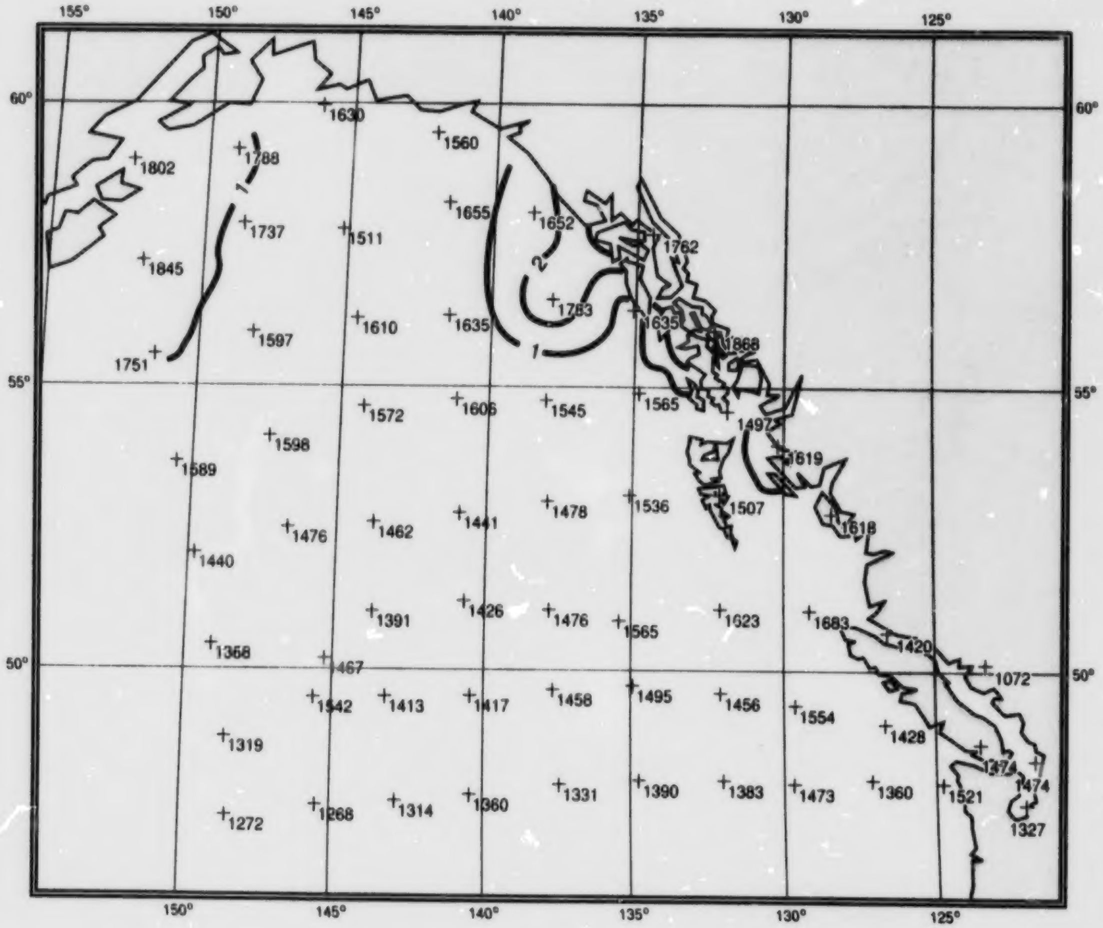
Figure 50. July wave height. Lines indicate percent frequency <= 2 meters (1949-1985) (after Brown et al. 1986)

In assessing the suitability of prevailing British Columbia climates for recreational purposes, Bennett (1977) considered not only land-based recreation, but aquatic recreation as well. In terms of aquatic activity, only the summer and transitional seasons, encompassing the period from April through October, were considered. Aquatic activities were considered to be insignificant during the winter period. In determining the suitability of climate for aquatic recreation, four representative "aquatic-passive" activities were considered: boating, sailing, fishing from a boat, and swimming. The aquatic-active class of recreational activities; e.g. canoeing, was not considered except in terms of temperature suitability as Bennett (1977) felt the number of recreational persuits to be very limited. Bennett suggested that if activities which fall into the aquatic-active class were being considered, it would be suitable to substitute the Climate Suitability for Recreation for land-passive activities. As kayaking and canoeing, both aquatic-active pursuits, are likely to be among the most prevalent visitor activities in the marine component of the South Moresby/Gwaii Haanas National Park Reserve, the substitution suggested by Bennett has been made in the following table giving passive and active activities the same suitablity ratings in terms of sunshine, wind and precipitation factors. The summer period is considered to extend from June through August, and the transitional seasons are from April through May and from September through October.

Climate Suitability for Aquatic Recreation

Factor:	Station:	Season:	Rating by Activity Active:	 Passive:
Temperature	Sandspit	Summer	mod. suitable	unsuitable
		Transition	unsuitable	least suitable
	C. St. James	Summer	suitable	mod. suitable
		Transition	mod. suitable	unsuitable
Sunshine	Sandspit	Summer	mod. suitable	
		Transition	mod. suitable	
	C. St. James	Summer	(unavailable)	
		Transition	(unavailable)	
Wind	Sandspit	Summer	mod. suitable	
		Transition	unsuitable	
	C. St. James	Summer	least suitable	
		Transition	least suitable	
Preciptn.	Sandspit	Summer	mod. suitable	
		Transition	unsuitable	
	C. St. James	Summer	unsuitable	
		Transition	least suitable	

While Bennett's recreational suitability ratings for the Queen Charlotte Islands region are generally low, it should be pointed out that the focus of the ratings is primarily terrestrial recreation. A valuable index in terms of not only outdoor comfort but survivability with respect to the danger of hypothermia in the marine environment is windchill. It can be used as a combined index of human discomforture.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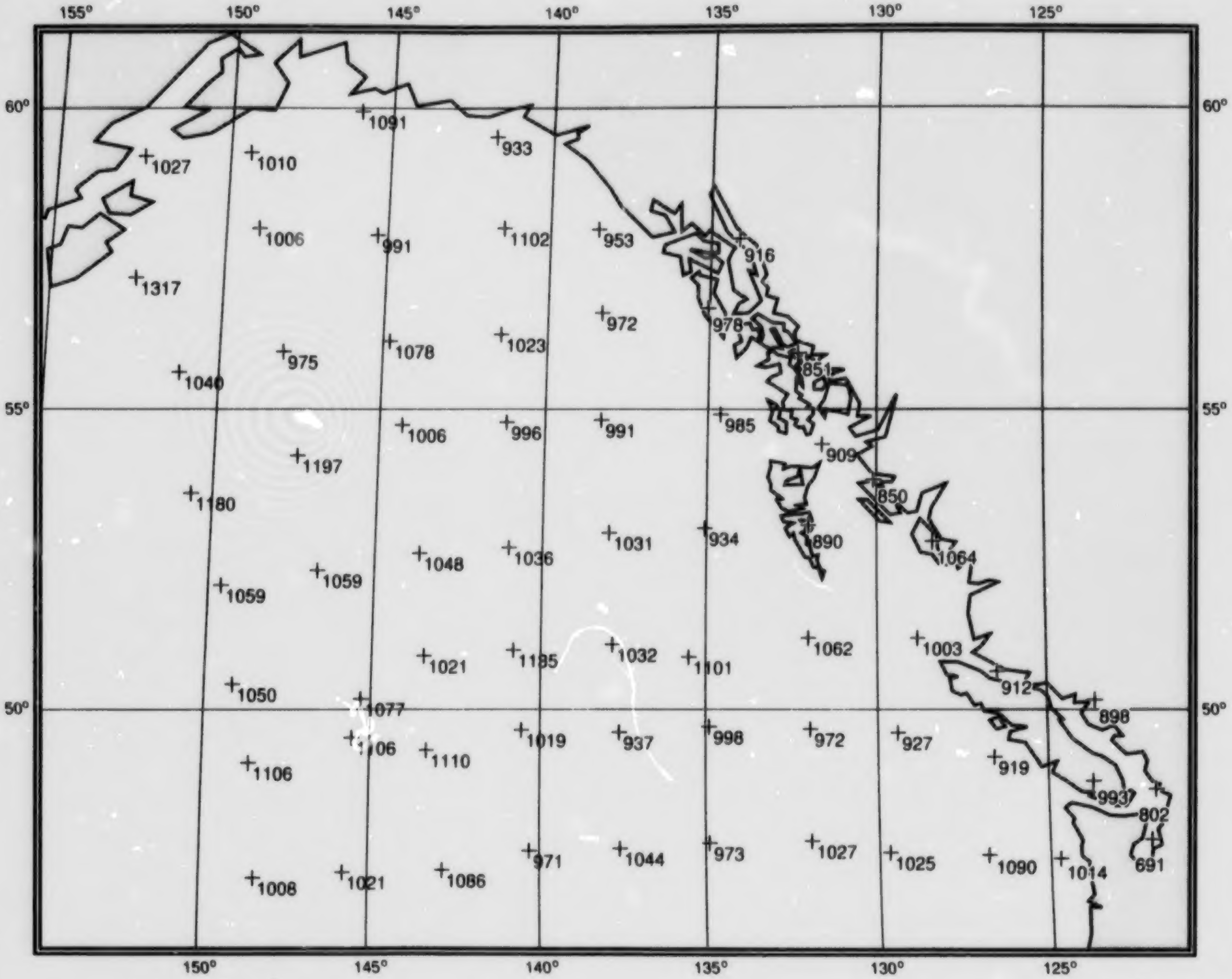
1751
1868
1572
1606
1545
1565
1497
1598
1589
1619
1536
1478
1441
1507
1462
1476
1618
1440
1426
1391
1476
1565
1623
1683
1368
1467
1420
1072
1542
1413
1417
1458
1495
1456
1554
1428
1319
1374
1474
1331
1390
1383
1473
1360
1521
1268
1314
1360
1327
1272
1
2

Figure 51. January windchill factors. Lines indicate percent frequency (from 1857-1985) >= 16600 W/m^2 and crosses indicate loction of maximum windchill (after Brown et al. 1986)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953
916
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972
978
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1023
975
1040
851
985
1006
996
991
909
1197
1180
850
1031
934
890
1048
1036
1064
1059
1059
1062
1003
1021
1185
1032
1101
1050
912
1077
898
1019
937
998
972
927
1106
1110
1106
919
993
802
971
1044
973
1027
1025
1090
1014
691
1008
1021
1086

Figure 52. July windchill factors. Crosses indicate location of maximum windchill (after Brown et al. 1986)

a) RESOURCE ANALYSIS

Like the terrestrial portion of the South Moresby/Gwaii Haanas National Park Reserve, the marine sector enjoys a mild, wet, humid climate wherein temperatures do not reach the extremes in the summer and winter which they do in the interior of British Columbia. But the nature of the marine environment is such that other hazards to travel on and above the sea present themselves in terms of wind, fog and low cloud. Much of the visitor access to and travel within the park reserve, as well as the operation of the park reserve itself, will depend upon good shipping weather which is severely restricted in the winter months. Poor visibility and strong winds are more likely to occur in January than in July.

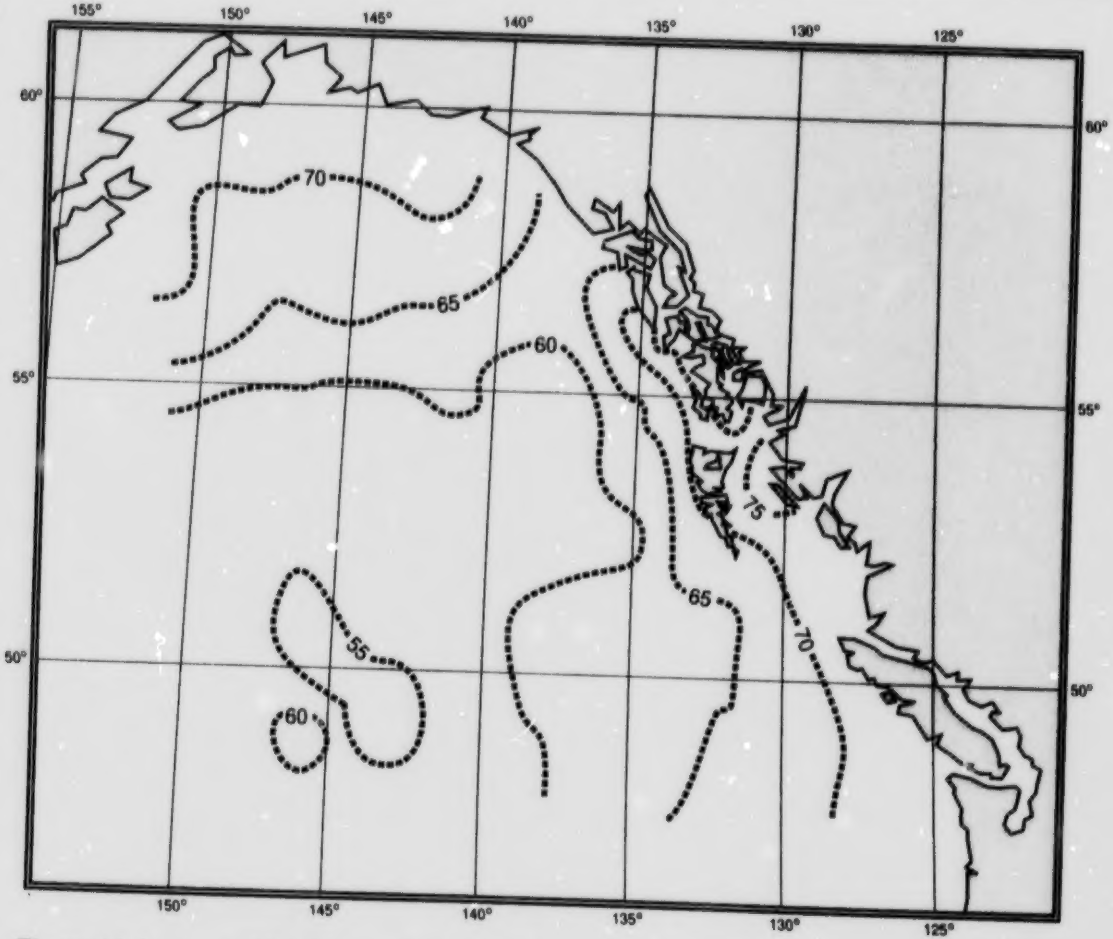
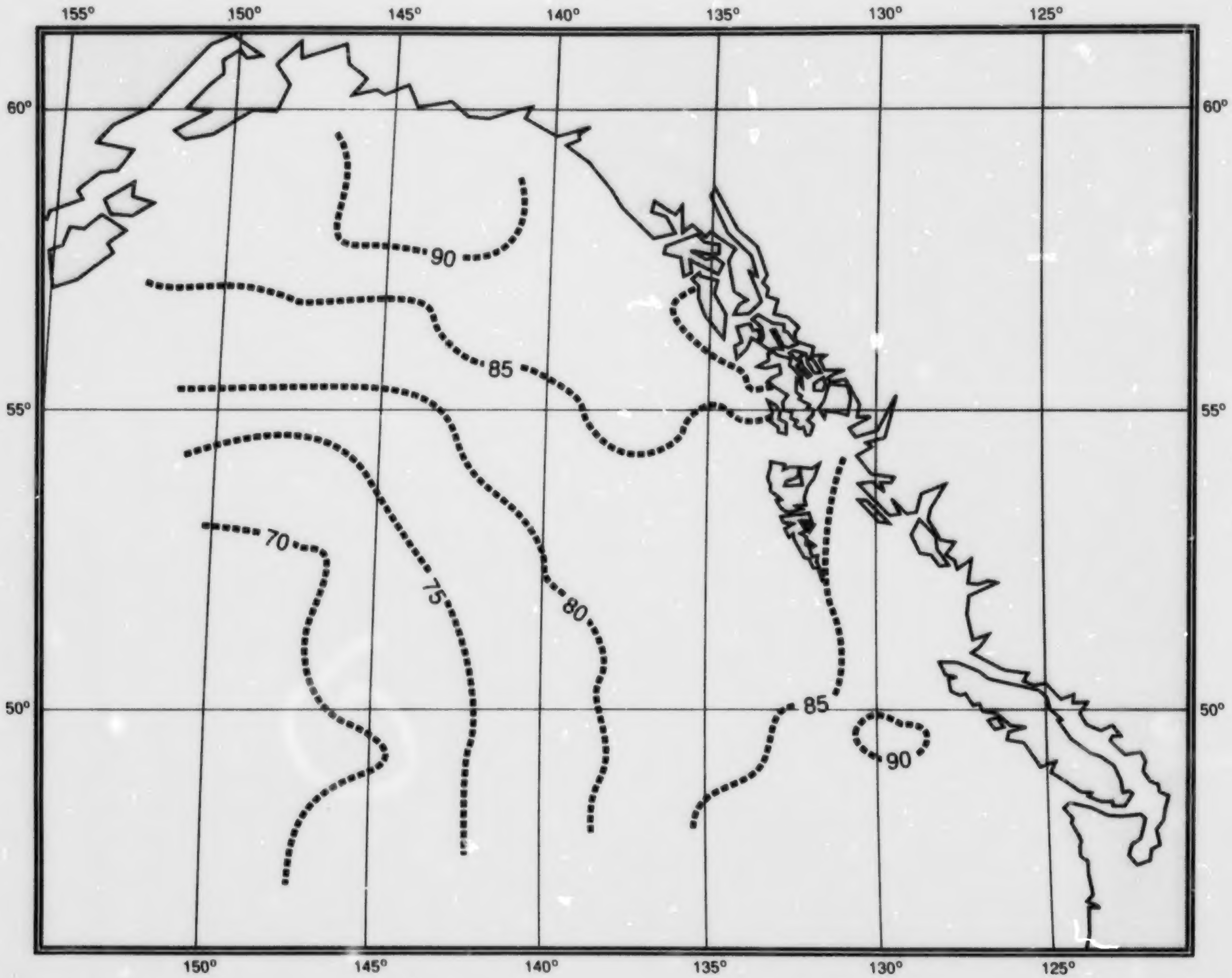


Figure 53. January shipping weather. Lines indicate percent frequency (1857-1985) of good shipping weather where the visibility is > 2.2 nmi. and the wind speed is < 25 knots (after Brown et al. 1986)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125°
60°
55°
50°
90
85
80
75
70
85
90

Figure 54. July shipping weather. Lines indicate percent frequency (1857-1985) of good shipping weather where the visibility is > 2.2 nmi. and the wind speed is < 25 knots (after Brown et al. 1986)

As well, the many visitors and Canadian Parks Service personnel who rely upon air access to the Queen Charlotte Islands will find the winter weather far more restrictive to travel than the summer weather. Low ceilings and fog conditions are more prevalent in the winter.

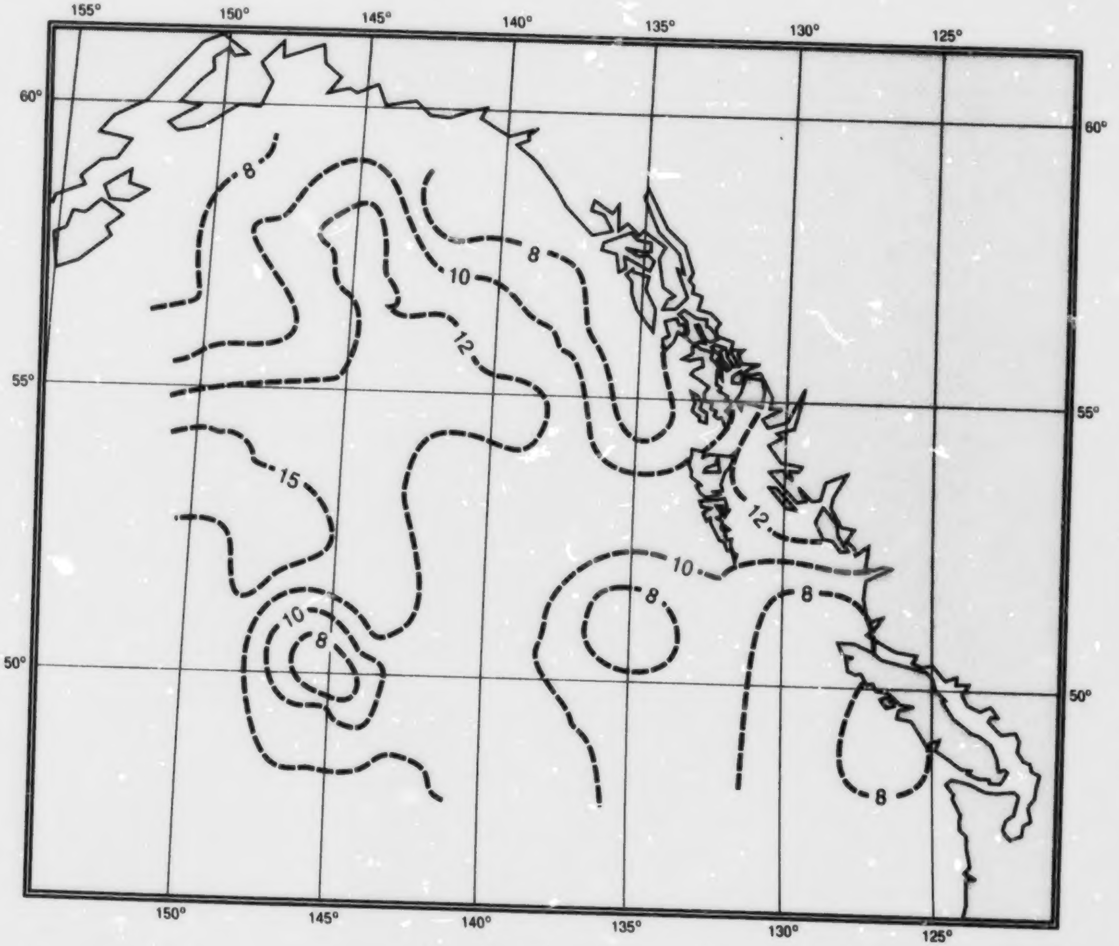

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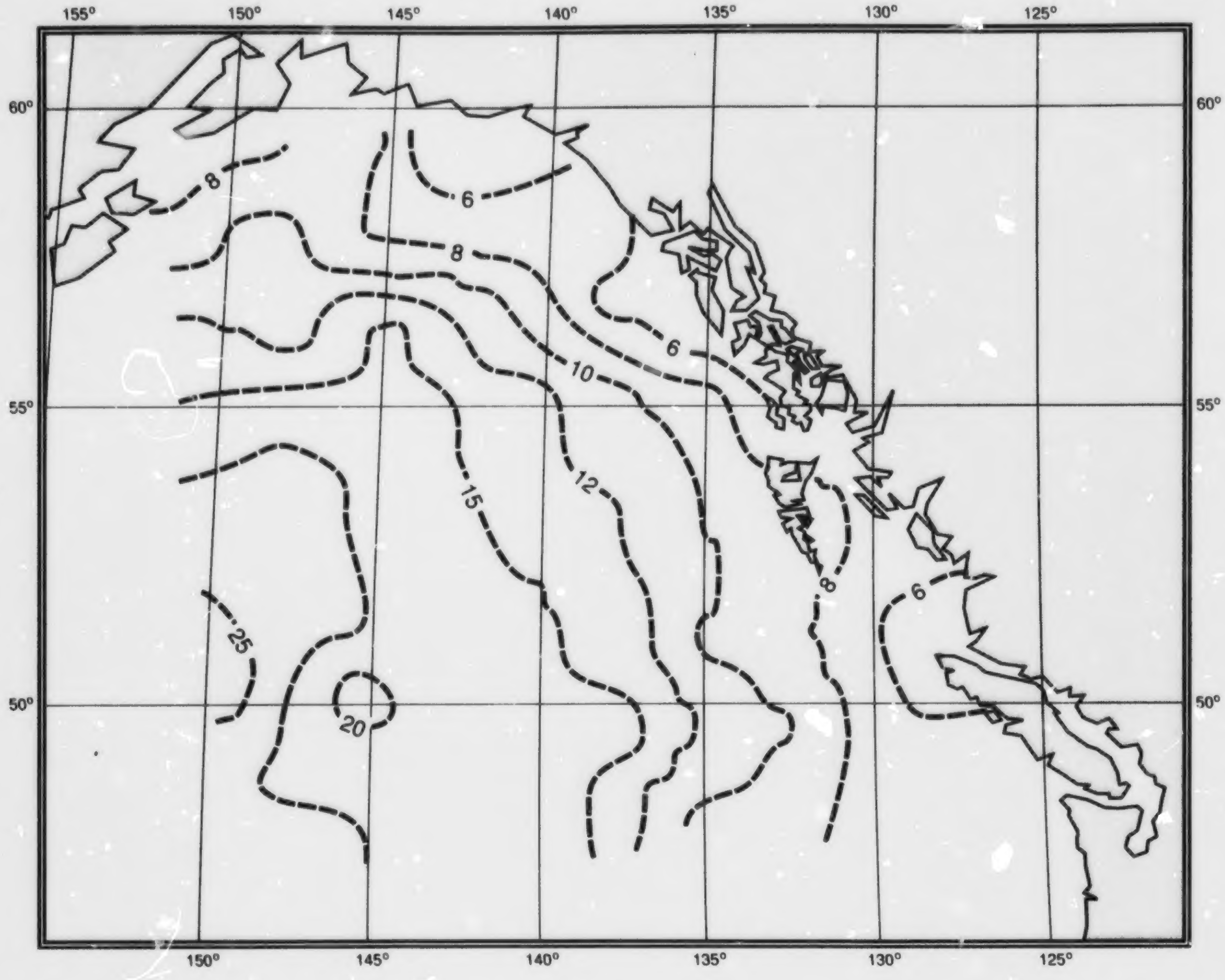
Figure 55. January flying weather. Lines indicate percent frequency (Aug. 1931-Dec. 1985) below IFR where visibility is 0.5nmi or ceiling is <100 ft. (after Brown et al. 1986)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25
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8
6

Figure 56. July flying weather. Lines indicate percent frequency (Aug. 1931-Dec. 1985) below IFR where visibility is <0.5nmi or ceiling is < 300 ft. (after Brown et al. 1986)

Immersion Hypothermia

Water Temperature:	Exhaustion/ Unconsciousness:	Survival Time:
0°C	15 min	15-45 min
0-5°C	15-30 min	30-90 min
5-10°C	0-60 min	1-3 hrs
10-15°C	1-2 hrs	1-6 hrs
15-20°C	2-7 hrs	2-40 hrs
20-25°C	3-12 hrs	3-indefinite hrs
25+°C	indefinite	indefinite

The water environment presents a unique danger to those travellers who either accidentally or intentionally find themselves in the sea and thus may experience immersion and hypothermia. At the sea surface temperatures found around the Queen Charlotte Islands, a person can be expected to lose consciousness in less than an hour and to survive no more than 3 hours (Thomson 1981).

With the removal of Ocean Weather Station PAPA, we must rely on the observations of ships of opportunity and occasionally-established weather buoys for records of marine climate. The coastal and lighthouse stations in the area can provide some data, but they do not serve to monitor open ocean conditions. The extrapolation of land-based meteorological measurements to offshore areas is risky due to the dramatic changes in the physical regime, and this becomes particularly difficult along the Canadian west coast where local climates are strongly influenced by topography (Brown et al. 1986). The danger in using land station data to represent wind extremes over the ocean is that maximum wind speeds are generally lower at coastal stations than over the water (Swail et al. 1984).

- Management Concerns

In any national park or national park reserve, weather is a deciding factor in terms of visitation and recreational activities. In the marine component of South Moresby/Gwaii Haanas National Park Reserve, the climate is a controlling factor not only in terms of visitation, but in terms of sheer mobility and the ability to carry out normal activities in every facet of park operations. Because of the fact that no regular and automatic system of obtaining instantaneous, "real-time" climate data exists, park managers will have to err always on the side of caution in making operational decisions. This could have serious consequences, particularly so in safety and rescue situations.

The ability to anticipate both fair and foul weather at any point in the day or night could give the Canadian Parks Service the margin of safety needed to avoid marine disasters and to act safely in the face of an emergency. The cost of a climate monitoring system to provide just such an ability cannot be weighed against improvements in operational effectiveness and increased levels of human safety.

- Status of Knowledge

What knowledge there is of the marine climate of the Queen Charlotte Islands offshore area, is based largely on intermittent data gathered at random points by ships of opportunity. Weather buoyage has been sporadic. Data collecting procedures aboard ships of opportunity have been as varied as the vessels themselves. The one fixed station of long duration, Ocean Weather Station PAPA, recorded weather data for a period of only 30 years, ending in 1981, and this at a substantial distance from the British Columbia coast.

Establishing weather buoyage to meet the need for instantaneous, statistically reliable weather data will not be an inexpensive nor easy proposition. But given the limitations on marine activity which the weather imposes, the effort must be made to improve our knowledge of climate. Moreover, the emplacement of weather buoyage will afford the Canadian Parks Service the ability to anticipate terrestrial weather.

Careful consideration will have to be given to the placement of weather buoyage, and the opportunity should be sought to cooperate both with the Atmospheric Environment Service, the Department of Fisheries and Oceans, and the Department of Transport, in the effort.

b) SELECT REFERENCE SOURCES

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Climatology of West Coast Marine Areas. Atmospheric Environment Service, Canadian Climate Centre Report No. 87-3, Downsview , Ontario. 95p.

Brown, R.D., N. Balaskas, L.D. Mortsch, A. Saulesleja, & V.R. Swail 1986.
Marine Climatological Atlas - Canadian West Coast. Atmospheric Environment Service, Canadian Climate Centre Report No. 86-10, Downsview, Ontario. 372p.

Thomson, R.E. 1989.
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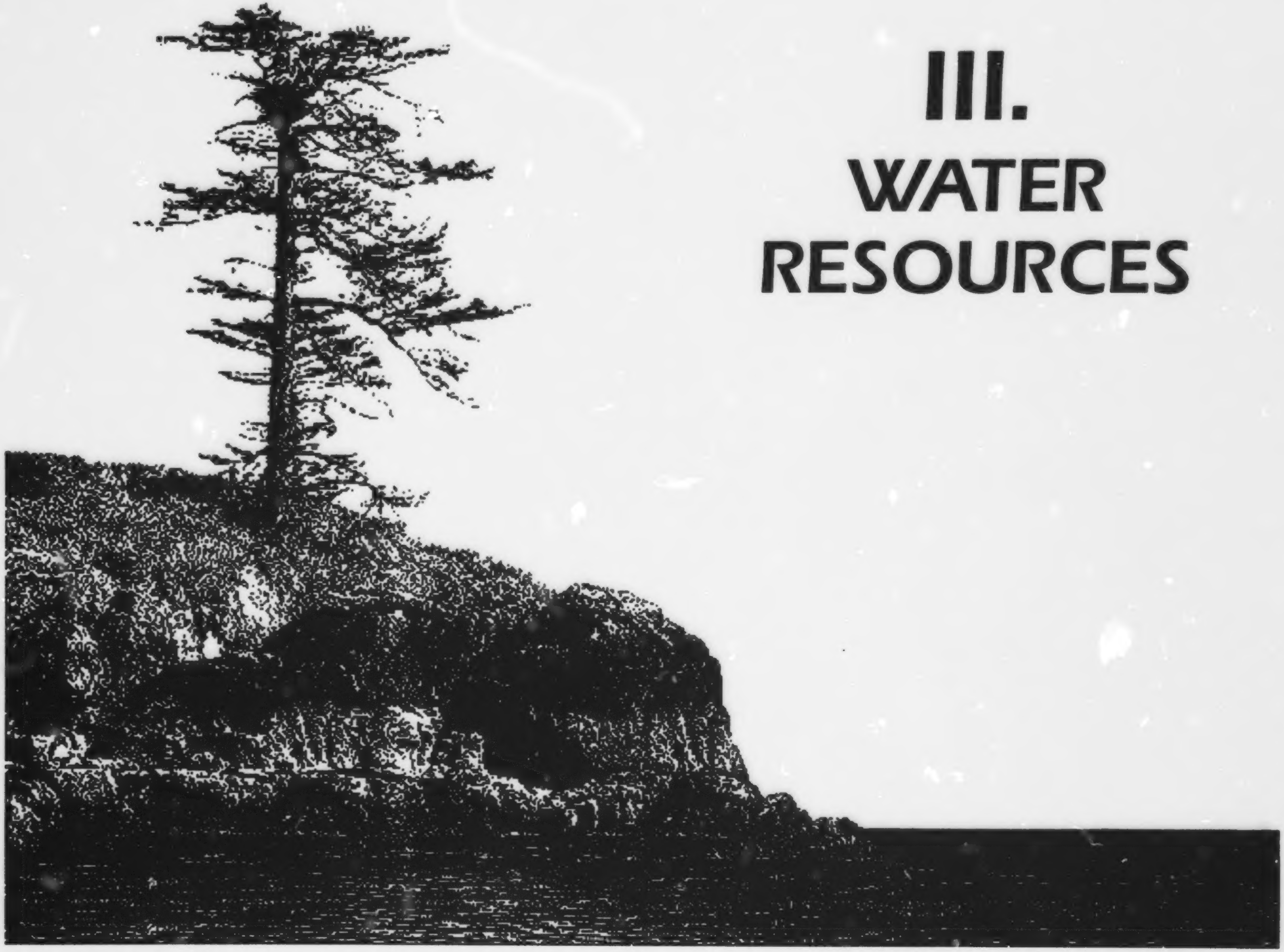
_________ 1981.
Oceanography of the British Columbia Coast. Can. Spec. Publ. Fish. Aquat. Sci. 56. 291 p.

III.
WATER RESOURCES



WATER RESOURCES

General Overview

With the highest annual precipitation, in excess of 4000 millimetres, the Queen Charlotte Island archipelago is indeed the best "watered" area in Canada. However, the physical configuration and narrowness of this landmass have not allowed multi-river drainage systems to evolve as has been the case on the mainland. The shortness of the valleys and the steepness of the largely mountainous terrain have resulted in the development of relatively short, high velocity streamlets that plunge their waters into the Pacific Ocean after only a very brief and rapid journey. In spite of the physical character of these streams, the South Moresby/ Gwaii Haanas National Park Reserve is rich in the diversity of its aquatic habitats which include freshwater streams and lakes, brackish estuaries, and a wide variety of marine habitats (Anon. 1988d; Anon. 1983b).

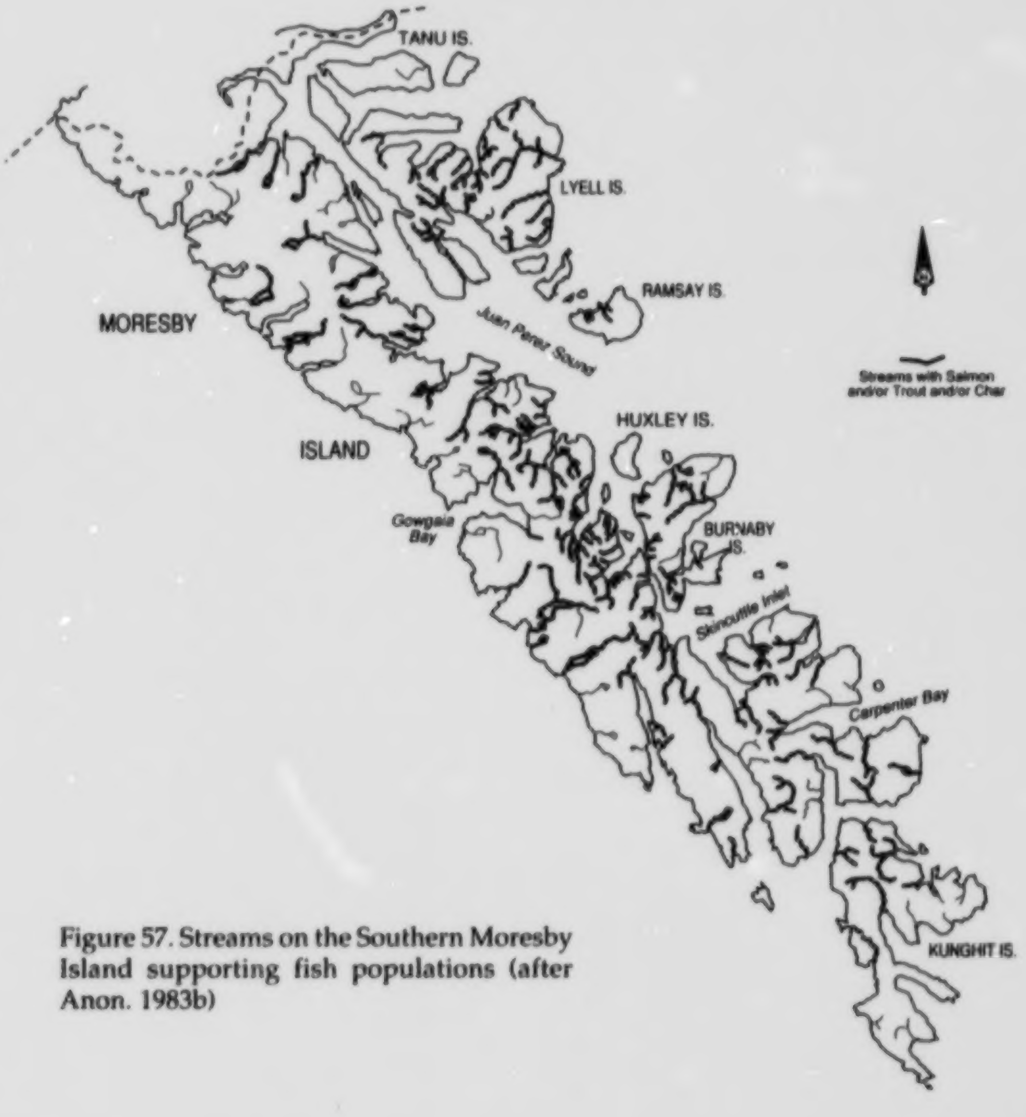

TANU IS.
LYELL IS.
RAMSAY IS.
Juan Perez Sound
MORESBY
ISLAND
HUXLEY IS.
Gowgaia Bay
BURNABY IS.
Skincuttle Inlet
Carpenter Bay
KUNGHIT IS.
Streams with Salmon and/or Trout and/or Char

Figure 57. Streams on the Southern Moresby Island supporting fish populations (after Anon. 1983b)

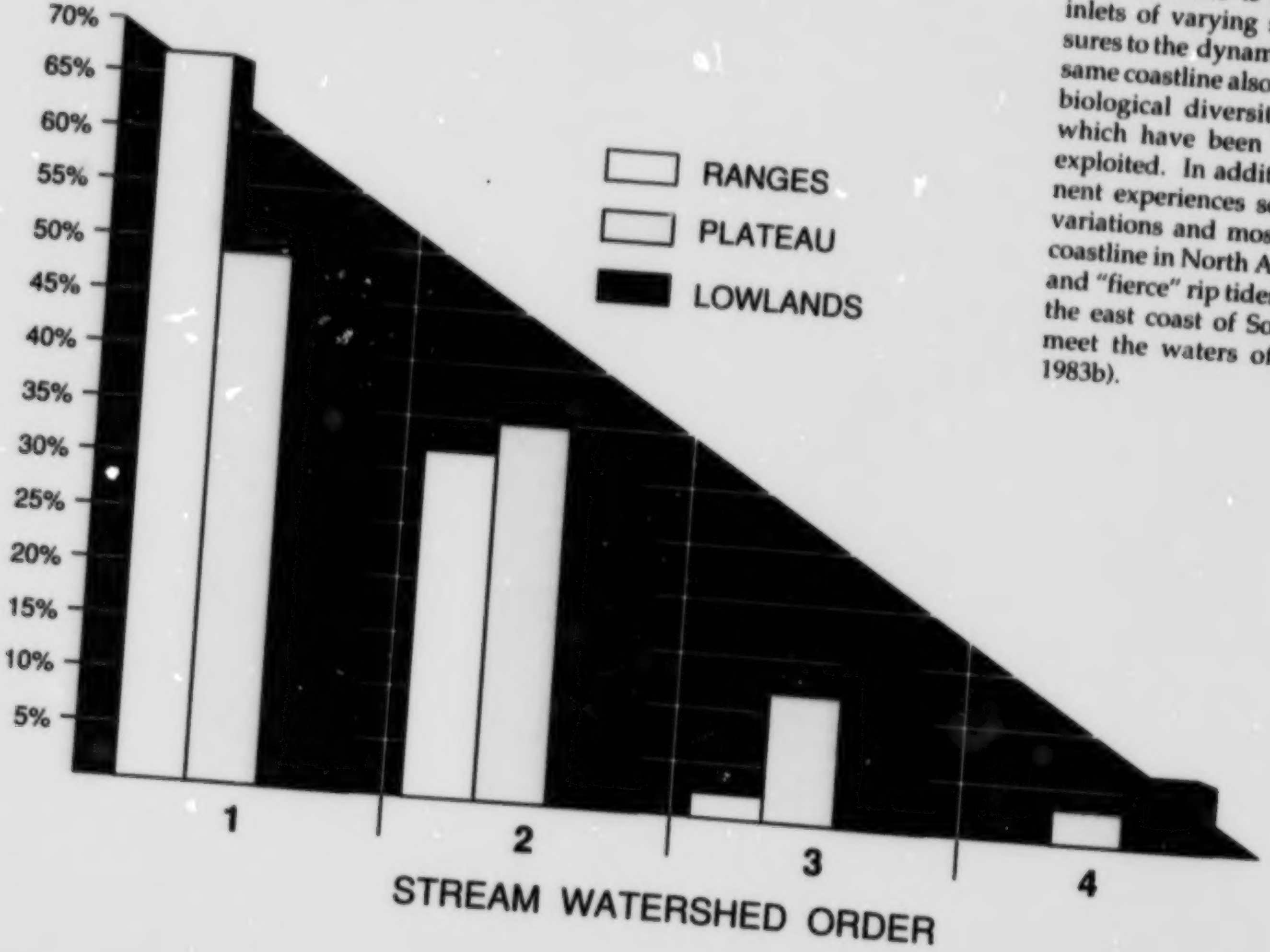


Figure 58. Relative contribution of stream watershed orders for the physiographic regions of the Queen Charlotte Islands

The marine environment of the proposed marine component of the South Moresby/Gwaii Haanas National Park Reserve is equally diverse. Its about 2000 kilometre-long coastline is profusely indented with inlets of varying sizes, lengths, and exposures to the dynamics of the open ocean. The same coastline also exhibits a high degree of biological diversity some components of which have been and are commercially exploited. In addition, this marine component experiences some of the largest tidal variations and most violent storms of any coastline in North America. Strong currents and "fierce" rip tides flow out of the inlets of the east coast of South Moresby Island to meet the waters of Hecate Strait (Anon. 1983b).

A. FRESHWATER RESOURCES

The rivers and streams of the Queen Charlotte Islands and their associated fish faunas have been strongly affected by the topographic, climatic and hydrographic differences caused by the peculiar characters of the three major physiographic regions in which they are situated; *i.e.* the Queen Charlotte Ranges, the Skidegate Plateau, and the Queen Charlotte Lowlands. Over 60 percent of the 419 rivers and streams of the archipelago carry water off the Queen Charlotte Ranges, both to the open Pacific Ocean and to the Hecate Strait (Northcote *et al.* 1989). Two-thirds of the rivers are 1st Order streams (Strahler 1957) that drain small, unbranched watersheds; furthermore, the Queen Charlotte Ranges contain only five, small, 3rd-Order streams, and no 4th-Order streams at all (Northcote *et al.* 1989). By comparison, the streams of the other two physiographic regions of the Islands predominate in stream orders 2, 3 and 4.

About 70 percent of the streams within the Queen Charlotte Ranges are supplied by watersheds less than 10 square kilometres in size. Almost 80 percent of them have a mainstem length of less than 5 kilometres, and their accessible length is less than 1 kilometre in almost 50 percent of the cases. Again by comparison, the streams of the Queen Charlotte Lowlands physiographic region possess in 60 percent of the cases watershed areas larger than 40 square kilometres. Almost 5 percent of them have mainstem lengths longer than 50 kilometres, and more than 20 percent have an accessible length of more than 20 kilometres.

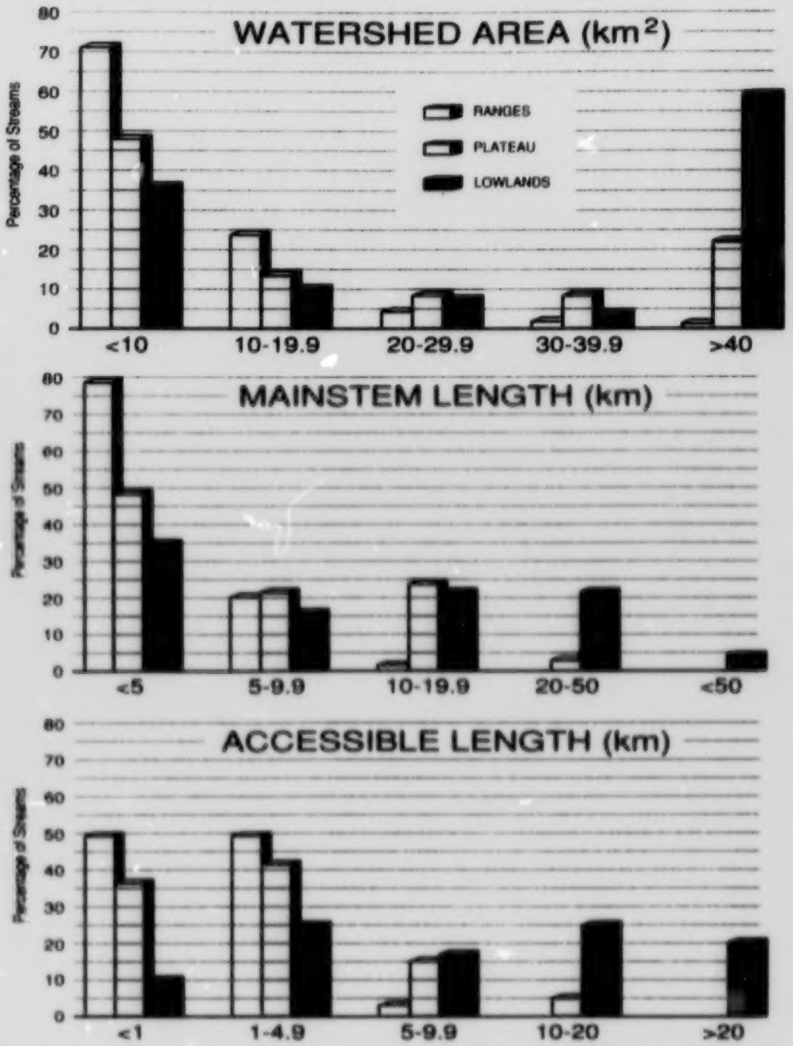


Figure 59. Morphometric characteristics of streams in the physiographic regions of the Queen Charlotte Islands (after Northcote et al. 1989)

Physiographic Region	Area (km²)	Coastline (km)	Rivers No.	Rivers %
Queen Charlotte Ranges	3017	1760	252	60.2
Skidegate Plateau	3654	633	99	23.6
Queen Charlotte Lowlands	3274	614	68	16.2
Totals:	**9945**	**3007**	**419**	**100.0**

(after Northcote *et al.* 1989)

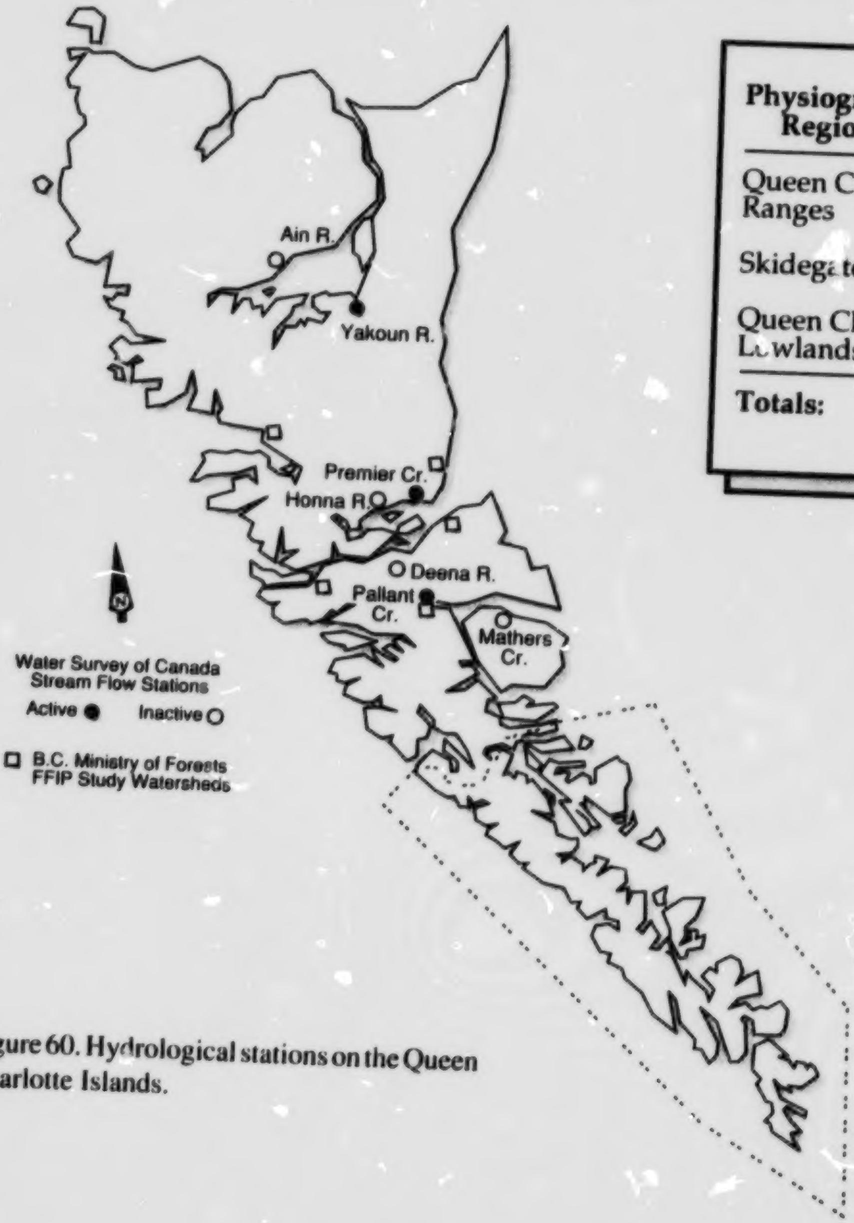

Ain R.
Yakoun R.
Premier Cr.
Honna R.
Deena R.
Pallant Cr.
Mathers Cr.
N
Water Survey of Canada Stream Flow Stations
Active ●
Inactive ○
☐ B.C. Ministry of Forests FFIP Study Watersheds

Figure 60. Hydrological stations on the Queen Charlotte Islands.

Sources of the relatively scant hydrological data available, are the federal Water Survey Branch and the Fish-Forestry Interaction Program of the British Columbia Ministry of Forests, both of which still maintain some flow measurement stations of their watershed studies. Unfortunately for the resource managers of the national park reserve, the study results referred to were for the most part collected in the more settled, central portions of the Islands; *i.e.* in the vicinity of Queen Charlotte City, Skidegate Mission, Sandspit and Moresby Camp. No streamflow measuring stations are known to have ever been operative, or are now operative, within the area of the national park reserve, and no hard data are available for the streams there; however, certain inferences can be made from the data that is available for the remainder of the Islands.

Northcote *et al.* (1989) reported that certain seasonal hydrographic measurements were available for select streams in each of the physiographic regions, even though they acknowledged that two of them, the Pallant and Yakoun drainage systems, contained large lakes capable of moderating their flow. Those records show quite clearly that the monthly means of daily stream discharge amounts are highest during the late autumn. They abate slightly during the winter months, and decline steadily until the summer lows are reached. Wide fluctuations of maximum daily discharge can occur between the autumn and winter months from year to year, and the flow of streams not modified by the presence of lakes within their drainages and situated on the western slopes of the Queen Charlotte Ranges are subjected to the widest fluctuations.

The same authors (Northcote *et al.* 1989) also provided somewhat less extensive data on the water temperature regimes of the same streams discussed foregoing. Even so, the presence of lakes (Mosquito Lake at Pallant Creek, Mathers Lake at Mathers Creek) along the length of two streams, once again had a modifying effect on their temperatures. Winter temperatures ranged from about 1 degree C. to 5 degrees C., while summer temperatures ranged from about 10 degrees C. to 22 degrees C. They noted, however, that the summer temperatures of Pallant Creek were much higher than is the average for most other mountain streams on the Islands.

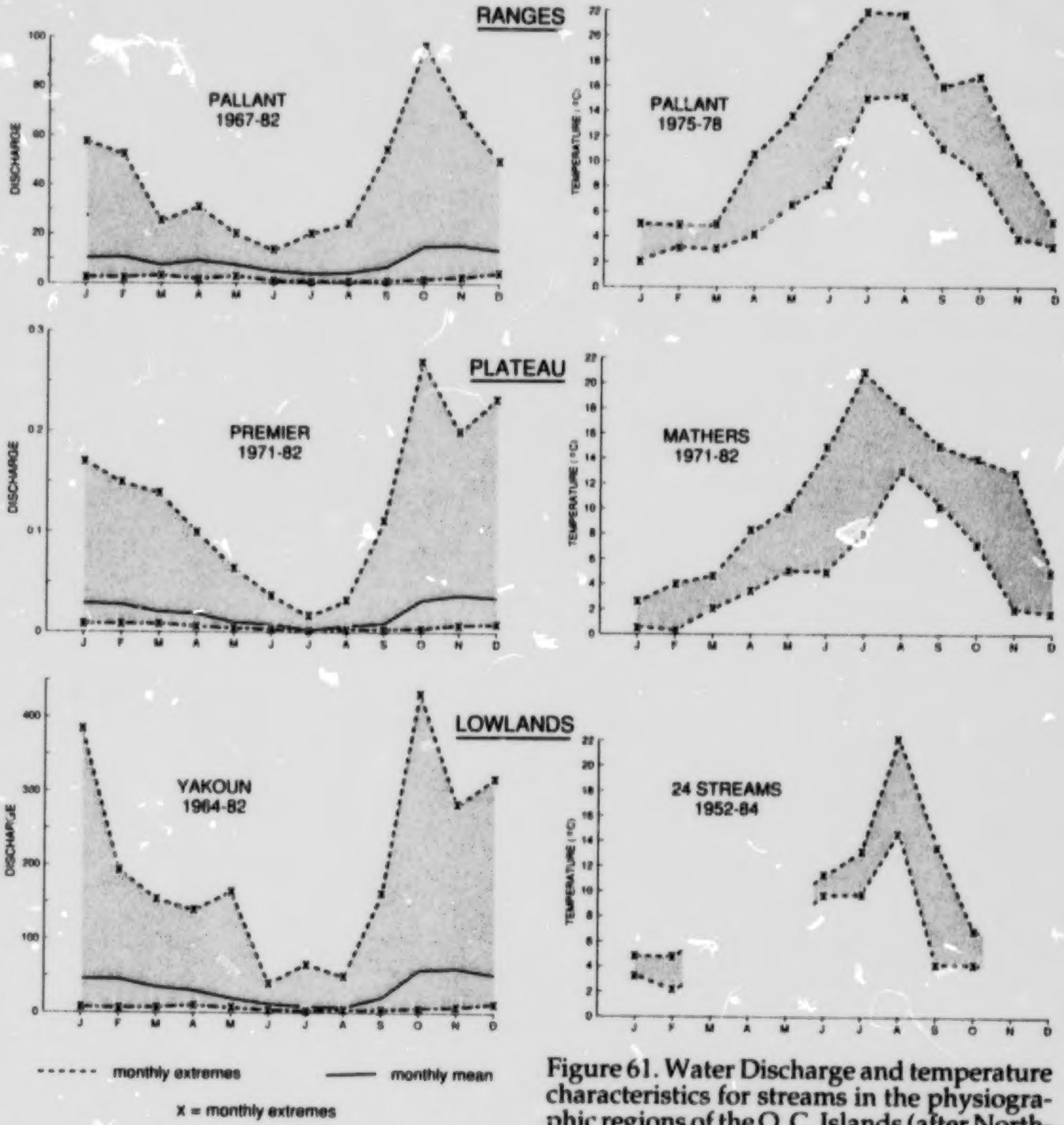


Figure 61. Water Discharge and temperature characteristics for streams in the physiographic regions of the Q. C. Islands (after Northcote et al. 1989)

Northcote *et al.* (1989) also presented certain water quality characteristics such as brown staining, conductivity and pH, for about 20 streams in each of the physiographic regions referred to earlier. The data show that streams in the Queen Charlotte Ranges and Skidegate Plateau regions are clearer than those in the Queen Charlotte Lowlands region which are moderately to heavily brown stained. On the other hand, streams within the Queen Charlotte Ranges region have low conductivity, while streams in the other two physiographic regions have a somewhat higher conductivity. The pH characteristics of the streams draining the Skidegate Plateau region are alkaline (pH 8+), those of the Queen Charlotte Ranges region are largely neutral (pH 6-7), and the streams of the Queen Charlotte Lowlands region are acidic (pH <5).

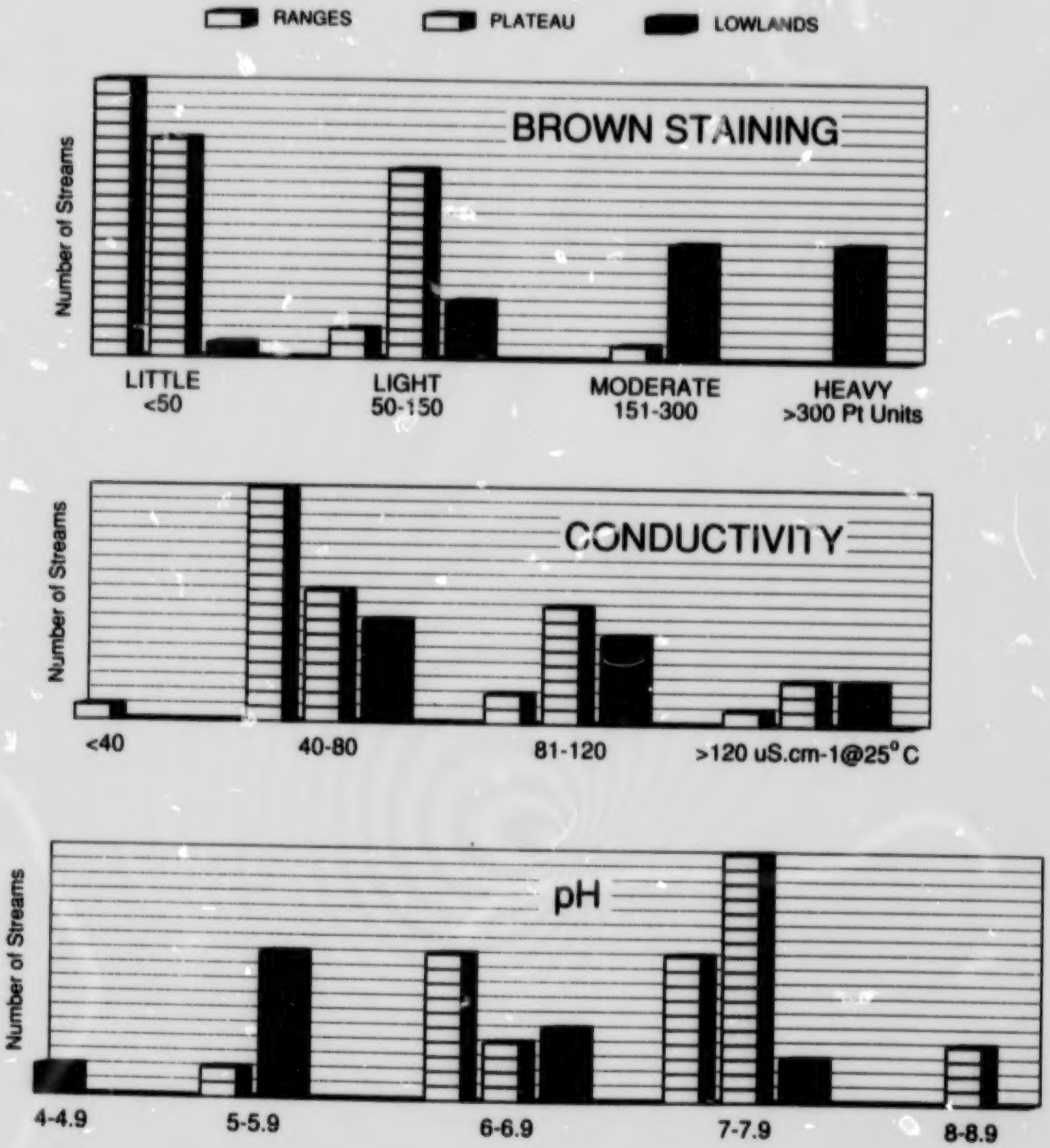


Figure 62. Averaged values of staining, conductivity and pH characteristics of streams in the Queen Charlote Islands (after Northcote et al. 1989)

From the foregoing and other precipitation and streamflow data, it can be extrapolated that the precipitation regime of the west coast and central portions of South Moresby Island is considerably wetter than is experienced elsewhere in the Queen Charlotte Islands. Streamflow reaches over 4 metres annually in places like Tasu Sound and Sewell Inlet, and is highest during the winter months. Most of the freshwater streams in the national park reserve rise in the San Christoval Mountains where the short and steep streams are fed by relatively small catchment basins, usually no larger than 20 square kilometres. It is common for them to reach sea level following short and narrow runs through their low-gradient floodplains which provide suitable and productive habitats for several freshwater and anadromous fish species (Anon. 1988d; Anon. 1983b).

There are more than 200 lakes of varying sizes on the Queen Charlotte Islands, but most of them are small and oligotrophic. In addition, there exist thousands of shallow bog pools, most of which are < 1 hectare in size and occur in the Queen Charlotte Lowlands physiographic region. Many of the latter pools and ponds dry out during the summer months and are therefore unable to support fish populations. Some of the other, larger lakes also lack fish populations because of major water falls at their mouths or on their outflow streams. Winter water temperatures of the lakes are somewhat modified by the close proximity to the Pacific Ocean, but altitudinally higher lakes or those of < 200 hectare in size, have been known to freeze over completely for several weeks each winter (Northcote *et al.* 1989).

Of the five largest lakes on the Queen Charlotte Islands; i.e. Ian Lake (1,860 hectare), Yakoun Lake (808 hectare), Skidegate Lake (698 hectare), and Eden Lake (570 hectare), all but Skidegate Lake are situated on Graham Island, while the latter is situated in the north-eastern portion of Moresby Island. The runoff from these lakes is weakly stained, and their pH is neutral to slightly acidic (pH 6-7). Although uncommon, two of the lakes support littoral macrophyte species.

All of the lakes in the South Moresby/Gwaii Haanas National Park Reserve are relatively small and are usually separated from the ocean by waterfalls, thereby not allowing anadromous fish to reach them (Anon. 1983b). However, various freshwater fish species apparently reached some of these lakes thousands of years ago and have evolved as unique forms, while other lakes have remained barren throughout post-glacial times and may provide unique opportunities for plankton studies. Upper and Lower Victoria Lakes on the west slope of the San Christoval Range are the largest lakes in the reserve. The waters of the lakes are usually clear with pH characteristics near neutral (pH 6-7.5). While the larger lakes rarely support any macrophytic species, aquatic plants are occasionally abundant in the smaller lakes and ponds (Northcote *et al.* 1989).

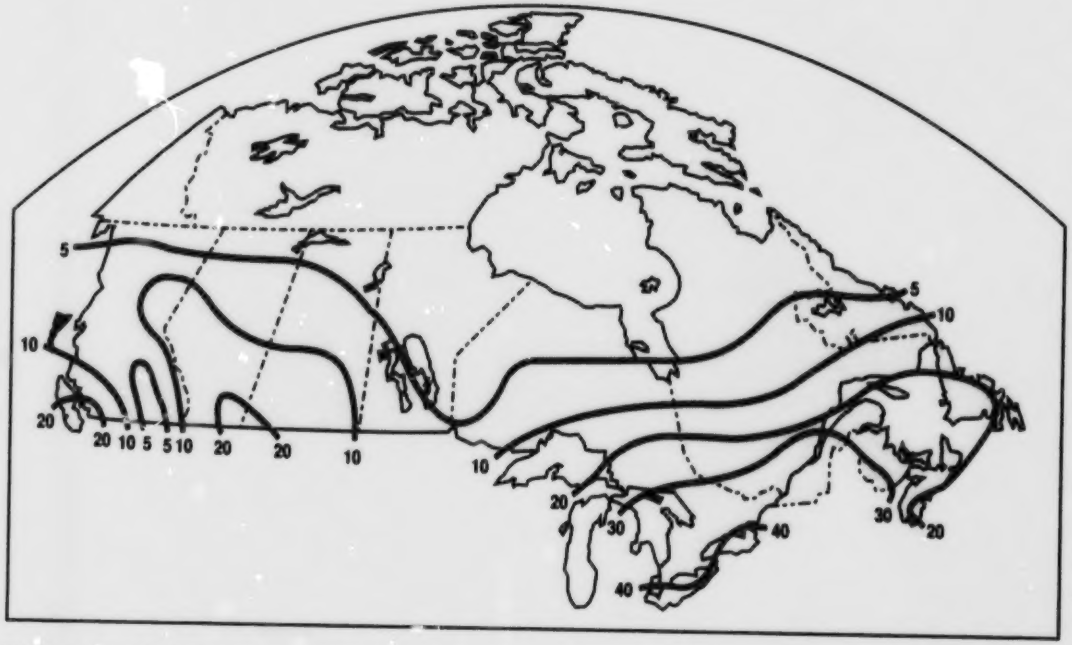


Figure 63. 1980 mean annual wet sulphate deposition in Canada - kg/ha/yr (after Anon. 1988e)

In terms of potential acidification of the surface waters of the South Moresby/Gwaii Haanas National Park Reserve, whether by anthropogenically produced atmospheric acids or by way of leaching from local bedrock types and soils, the situation requires monitoring. The 1980 mean annual wet sulphate deposition from industrial and cultural activities over the entire Queen Charlotte Islands ranged between 5 and 10 kg/ha/year (Anon. 1988e). It is among the lowest readings across industrialized Canada.

Major bedrock and soil characteristics of an area have the capability to affect or to be affected by the chemistry of the atmospheric deposition and thereby modify the chemistry of the surface waters as well. The bedrock and soils of the Queen Charlotte Islands exhibit the following sensitivities (Anon. 1988e):

Potential to Reduce Acidity:	Bedrock & Soil Characteristics:	**Potential Sensitivity of Surface Waters to Acidification:**
LOW	- mainly non-carbonate bedrock; - shallow soils, coarse texture, low cation exchange capacity, low sulphate adsorption capacity, low pH;	HIGH
MODERATE	- mainly non-carbonate bedrock; - shallow soils, moderate cation exchange and sulphur adsorption capacities, moderate pH;	MODERATE
UNRATED	- dominated by peatlands of variable chemistry; the depth of these organic soils is > 40 cm	MODERATE

a) RESOURCE ANALYSIS

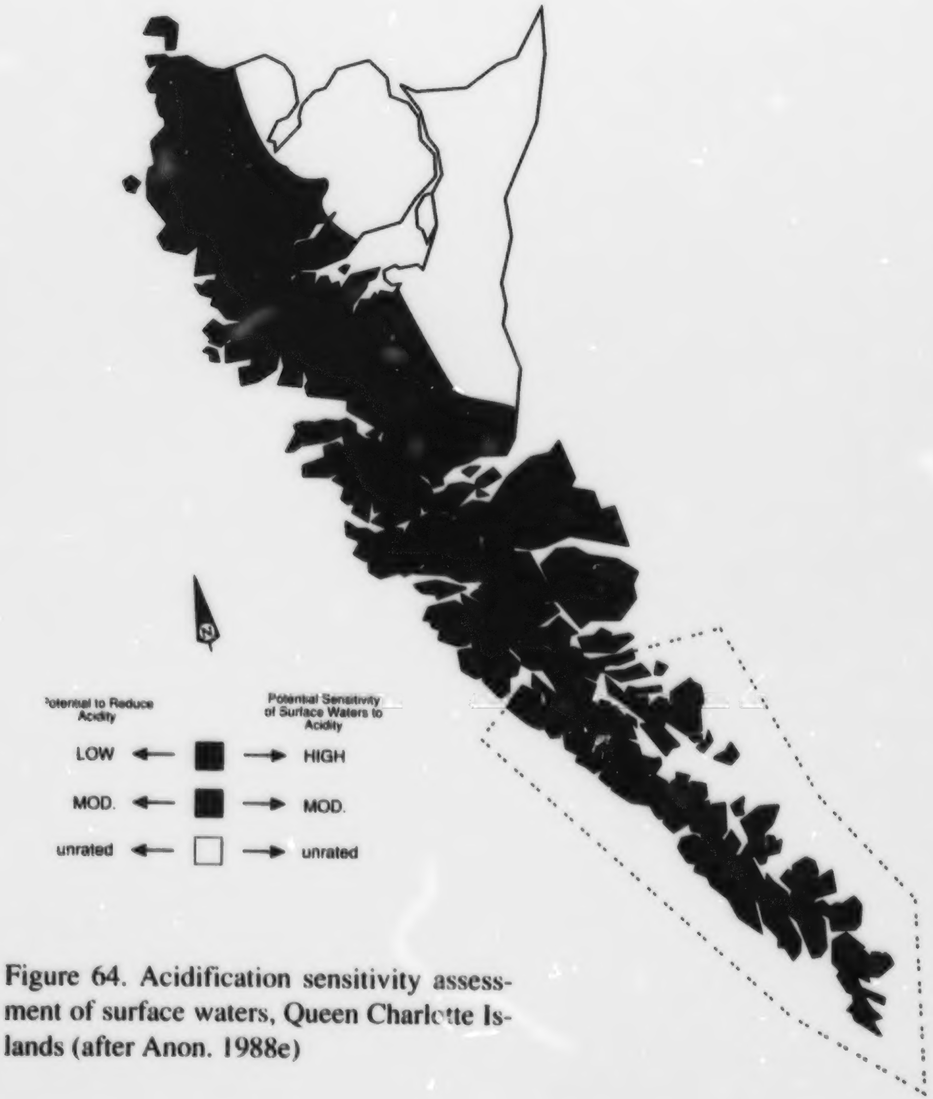

otential to Reduce Acidity
Potential Sensitivity of Surface Waters to Acidity
LOW
HIGH
MOD.
MOD.
unrated
unrated
N

Figure 64. Acidification sensitivity assessment of surface waters, Queen Charlotte Islands (after Anon. 1988e)

Considering the Queen Charlotte Islands as a hydrologic unit, the widely dispersed, intermittent, and non-integrated type of aquatic studies carried out over the years, have nevertheless produced a broad overview of the current hydrological conditions. The park reserve's resource managers can begin to extrapolate information from those studies that may find application to South Moresby Island. Much needs to be done in terms of hydrologic studies before there exists a data base of actual measurements that can begin to provide a clear picture of specific streamflow regimes, their water quality characteristics, and their biological capability to support aquatic vegetation and fish stocks.

Several authors of hydrological reports have stated specific warnings that the serious decline in salmon stocks may in part be the result of declining environmental health of the stream habitats. It would appear that landslide and debris flow activities during the rainy seasons, and often following seismic activity, have played a part in disrupting stream habitats and fish spawning areas within them. Other stream debilitating factors mentioned were logging practices and industrial pollution.

It would appear that the streams and fish habitats of the South Moresby/Gwaii Haanas National Park Reserve are presently in a better environmental condition and are in a less disturbed and manipulated state, than are most of the streams draining the remaining landmass of the Queen Charlotte Islands.

- MANAGEMENT CONCERNS

The most serious management concerns have to be directly related to the recently amended section of the National Parks Act which mandates that (Anon. 1988f):

5. (1.2) Maintenance of ecological integrity through the protection of natural resources shall be the first priority when considering park zoning and visitor use in a management plan.

With the mandate to maintain "ecological integrity", it is imperative that the ecological condition of the hydrological resources of South Moresby/Gwaii Haanas National Park Reserve be studied systematically and understood prior to park zoning being contemplated and visitor use activities and levels being prescribed. Given the absence of any streamflow data and the availability of only interpolated precipitation data for the western coastal area and the rain shadow effect area of the eastern coast of the island, no resource manager or park manager is really in a position at this time to pass knowledgeable judgement on the status of ecological integrity of the hydrological resources within the park reserve.

- STATUS OF KNOWLEDGE

There exists no scientific data base of strictly hydrological information that would elucidate the current condition of the streams and lakes within the park reserve, nor of their associated fauna and flora. What data there is relates primarily to the commercially exploitable aspects of the anadromous fishery at and near the mouths of streams and is not sufficient to assist with the thoughtful management of a national park.

In combination with a yet to be developed climate station network throughout the South Moresby/Gwaii Haanas National Park Reserve, it is seen as imperative that a comprehensive set of hydrological stations be integrated into that network so that streamflow, sediment transport, water quality, flood hazards, slope stability, and ecological and biological integrity of the aquatic environments can be monitored consistently. Only in this manner can the presently poor status of knowledge be improved significantly.

b) SELECT REFERENCE SOURCES

Anonymous 1988d.
South Moresby National Park: Biophysical Literature Review and Annotated Bibliography, Volume 1, Literature Review. MacLaren Plansearch, Vancouver, British Columbia. pp. 12-16.

________ 1988e.
Acid Rain: A National Sensitivity Assessment. Inland Waters and Lands Directorate, Environment Canada, Fact Sheet 88-1, Ottawa, Ontario. 6p., map.

________ 1983b.
South Moresby: Land Use Alternatives. South Moresby Resource Planning Team, British Columbia Ministry of Forests. The Queen's Printer, Victoria, British Columbia. pp.51-54.

________ 1978a.
Hydrological Atlas of Canada. Fisheries and Environment Canada. Minister of Supply and Services, Ottawa, Ontario. 34 maps.

Northcote, T.G., A.E. Peden & T.E. Reimchin 1989.
Fishes of the Coastal Marine, Riverine and Lacustrine Waters of the Queen Charlotte Islands. IN: The Outer Shores, G.G.E. Scudder and N. Gessler (eds.), Queen Charlotte Islands Museum, British Columbia. pp. 147-174.

B. MARINE WATER RESOURCES

For the purpose of this description, marine water resourses may be taken to be synonymous with oceanography. However, bathymetry has already been considered under the regional perspective, and will be treated again in its relation to marine geological resources. Topics to be covered under the heading of marine water resources include waves, tides, circulation, and water properties.

WAVES

In considering wave action in the vicinity of the South Moresby/Gwaii Haanas National Park Reserve, it is prudent to separate the more sheltered waters of Dixon Entrance, Hecate Strait and Queen Charlotte Sound from the less sheltered waters offshore. Wave energy levels differ in the two regions, as do several facets of oceanography and marine environment. Wave energy levels are even lower in the very protected waters amongst the coastal islands and inlets to the mainland side of Hecate Strait and Queen Charlotte Sound.

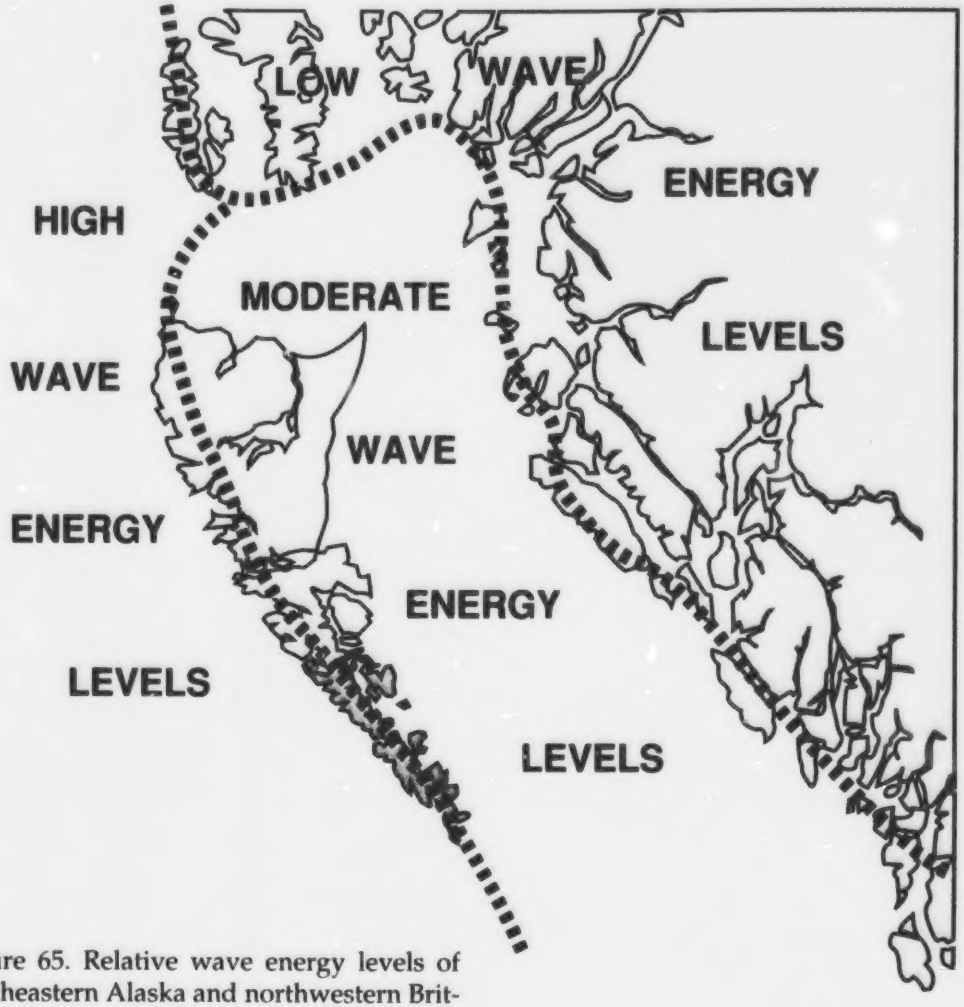


Figure 65. Relative wave energy levels of southeastern Alaska and northwestern British Columbia (after Claque & Bornhold 1980)

It is possible to distinguish two types of wind-generated surface gravity waves on the basis of origin, period and energy (Anon. 1983a): swell waves and sea waves. Whereas the long-period swell waves which have escaped their area of origin can travel quickly over great distance with little loss of energy, the shorter, steeper sea waves which are produced by local winds can be less predictable and thereby more hazardous. Because the length, speed, and period of waves in a fully developed sea are interrelated, it is possible to predict wave height by comparing measured values of wind speed , fetch and duration with average wave energy. Likewise, significant wave height, the average height of the highest one-third of all observed waves (which is closely approximated by the height of visually observed waves), can serve as a simplified measure of a sea state.

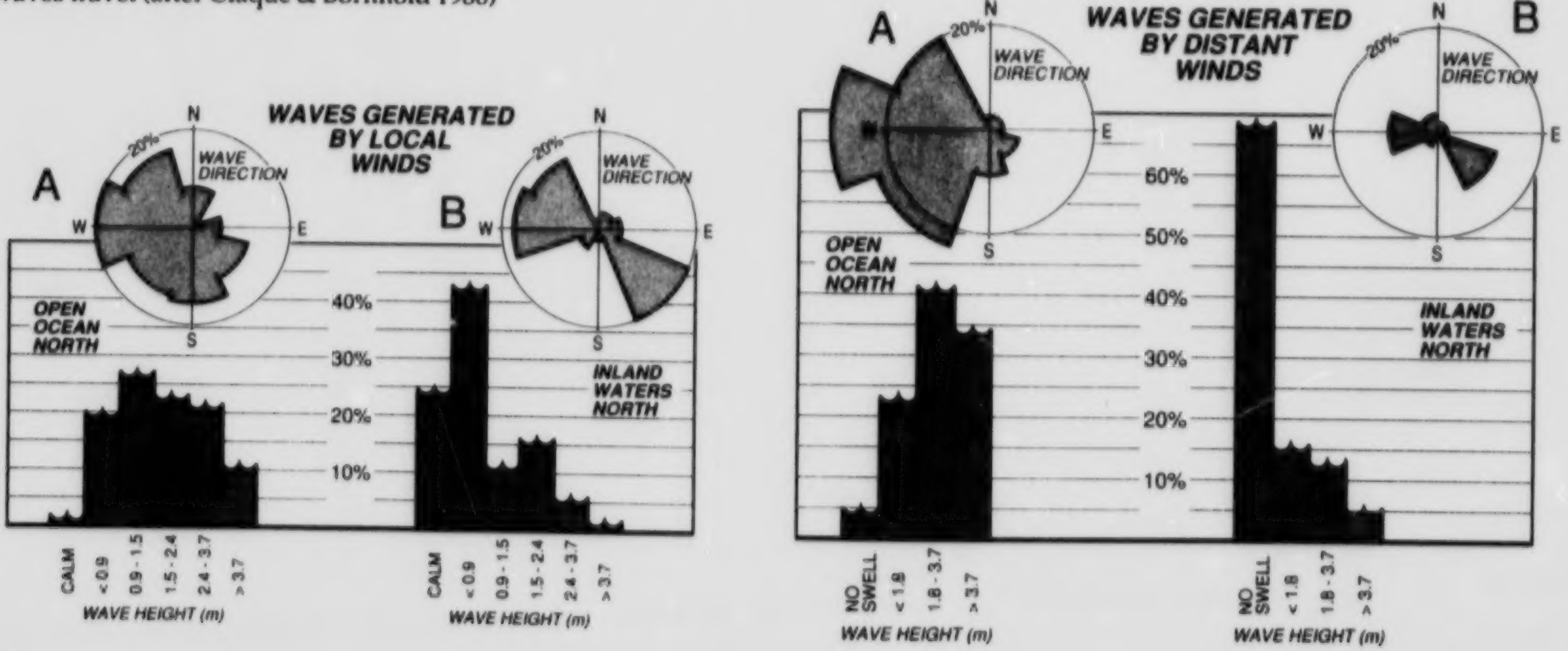


Figure 66. Wave heights and directions in A) the north Pacific Ocean off the Queen Charlotte Islands and B) Hecate Strait & Georgia. Plotted directions are those from which the waves travel (after Claque & Bornhold 1980)

As has been the case with the climatic record, the offshore oceanographic record is largely based upon observations by ships of opportunity as far back as the last century. The historic record is, therefore, biased towards shipping lanes and towards good weather. As well, visual estimates of wave height tend to underestimate the actual height of the lower waves, though the estimates for higher waves are generally accurate (Thomson 1989; Thomson 1981). Ocean Weather Station PAPA (at 50° N 145° W) was capable of providing more accurate deep-sea information up to 1981.

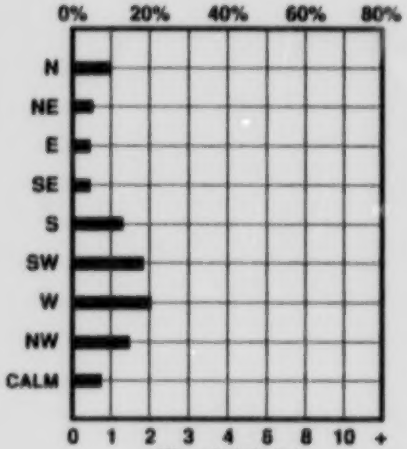
The driving force in the production of swell and local sea waves are the predominating pressure systems, (a) the Aleutian Low and associated migratory cyclones are the major cause of wave action during autumn and winter, and (b) the North Pacific High dominates during the spring and summer (Clague & Bornhold 1980).

Offshore, both sea and swell are highest in the summer and lowest in the winter in direct relation to the strength and direction of the oceanic winds. Swell, being little affected by local wind, takes the direction of the prevailing wind which is southwest and west in the winter and southwest to northwest in the summer. Seas, being more readily affected by local wind, undergo far more shifting, but the prevalent offshore directions are the same as those for swells.

JANUARY

Height (m)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0 - 0.5	2	+	0	0	0	0	6
1 - 1.5	9	9	3	1	+	+	1
2 - 2.5	5	10	8	3	1	+	1
3 - 3.5	1	7	5	4	2	1	1
4 - 5.5	1	3	5	2	1	1	+
6 - 7.5	0	1	2	2	+	+	+
8 - 9.5	0	+	1	0	+	1	0
≥ 10	0	0	0	+	+	+	0

1737 OBSERVATIONS



1730 OBSERVATIONS

N	+	2	2	2	1	1	0	+
NE	+	2	2	1	+	+	0	0
E	+	2	2	1	+	+	0	0
SE	+	2	1	1	+	+	+	0
S	+	4	4	2	2	1	+	0
SW	+	4	6	4	4	1	+	0
W	+	3	7	5	4	1	+	0
NW	+	4	4	3	2	1	+	+
CALM	6	1	+	+	+	+	0	0
TOTALS	8	23	29	20	14	5	1	1

0 1 2 3 4 6 8 10 +

Wave Height (m)

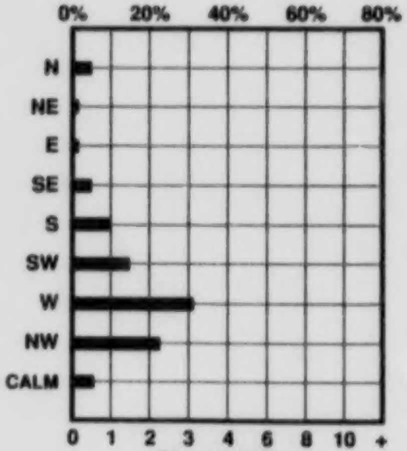
1730 OBSERVATIONS

+ indicates <0.5% but >0

JULY

Height (m)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0 - 0.5	14	2	1	+	0	0	5
1 - 1.5	25	20	6	2	+	+	2
2 - 2.5	3	6	5	1	+	+	+
3 - 3.5	+	1	2	1	+	0	+
4 - 5.5	+	1	+	+	+	0	0
6 - 7.5	0	+	0	0	0	0	0
8 - 9.5	0	0	0	0	0	0	0
≥ 10	0	0	0	0	0	0	0

1973 OBSERVATIONS



1931 OBSERVATIONS

N	1	4	2	1	+	0	0	0
NE	+	1	+	+	0	0	0	0
E	1	1	+	+	0	0	0	0
SE	1	2	1	+	+	0	0	0
S	2	6	1	+	+	0	0	0
SW	3	9	3	1	+	+	0	0
W	5	19	6	2	+	+	0	0
NW	4	13	4	1	+	+	0	0
CALM	5	1	+	0	0	0	0	0
TOTALS	20	58	16	5	1	+	0	0

0 1 2 3 4 6 8 10 +

Wave Height (m)

1931 OBSERVATIONS

Figure 67. Wave statistics for the area west of Queen Charlotte and Vancouver Islands (after Anon. 1987b)

The record of direct measurements of offshore wave heights has come from only three locations off the British Columbia coast: Cobb Seamount, the site of a bottom-mounted spressure recorder; Ocean Station PAPA, with its shipborne recorder; and 5.5 kilometres southwest of Longbeach, Vancouver Island, the location of a waverider buoy (Thomson 1989). Of these, only Ocean Station PAPA had an actual deep-sea location. There, waves have exceeded 4 metres 30 percent of the time, while rarely going above 10 metres. Heights measured at Cobb Seamount have been similar, whereas the data recorded off Vancouver Island indicate waves over 3 metres only 4 percent of the time.

While wave energy in the inland waters adjoining the Queen Charlotte Islands is greater than that found in the inland waters south and east of Vancouver Island, it is appreciably less than that of the offshore (Clague & Bornhold 1980). Even within the coastal domains, there is a gradation; the wave heights being highest in Queen Charlotte Sound, intermediate in Dixon Entrance, and lowest in Hecate Strait, all in conjunction with the degree of exposure and the extent of the water bodies (Thomson 1989). Swells from the west and southwest enter Queen Charlotte Sound unchanged, while those from the northwest and south are modified by refracted waves and by the shallowing bathymetry. So swells entering Dixon Entrance from the west, southwest and northwest are rapidly attenuated as they move inland. Most waves within Dixon Entrance are of the smaller variety produced by local winds, though the bottom contours, particularly in the vicinity of Learmonth Bank, have the tendency to amplify waves into rips as they move against an accelerated ebb current over the bank. The waves of Hecate Strait owe their origins as much to cyclonic winds from the northwest and southeast as to wave action penetrating from the open ocean. Steep seas can generate rapidly over the broad shoals adjacent to the east coast of the Queen Charlotte Islands.

As elsewhere in the region, wave energy levels in the coastal domains are greatest in autumn and winter and least in late spring and summer. Sudden, extreme wave conditions are more liable to arise in fall. One of the best documented recent examples of the sudden build-up of extreme wave conditions occurred in 1968 at the Shell Drill Rig, SEDCO 135F, as it was positioned in 137 metres of water off Cape St. James in Queen Charlotte Sound (Thomson 1981). Beginning in mid-October, the rig faced 16 days of 9-15 metre waves. The worst conditions occurred on 22 October as winds of 80 knots combined with sea and swell from the southwest and southeast to produce significant waves of over 20 metres in height. The arival of a 30 metre wave coincided with a opposite ebb current out of Queen Charlotte Sound (James 1969).

Significant wave heights of the type experienced by SEDCO 135F are on the order of a once in 100 year occurrence, though an extreme wave of the sort which struck on 22 October 1968 might be anticipated once in 50 years. The offshore oil industry relies on the 100 year return period wave as its design criterion for platforms and structures.

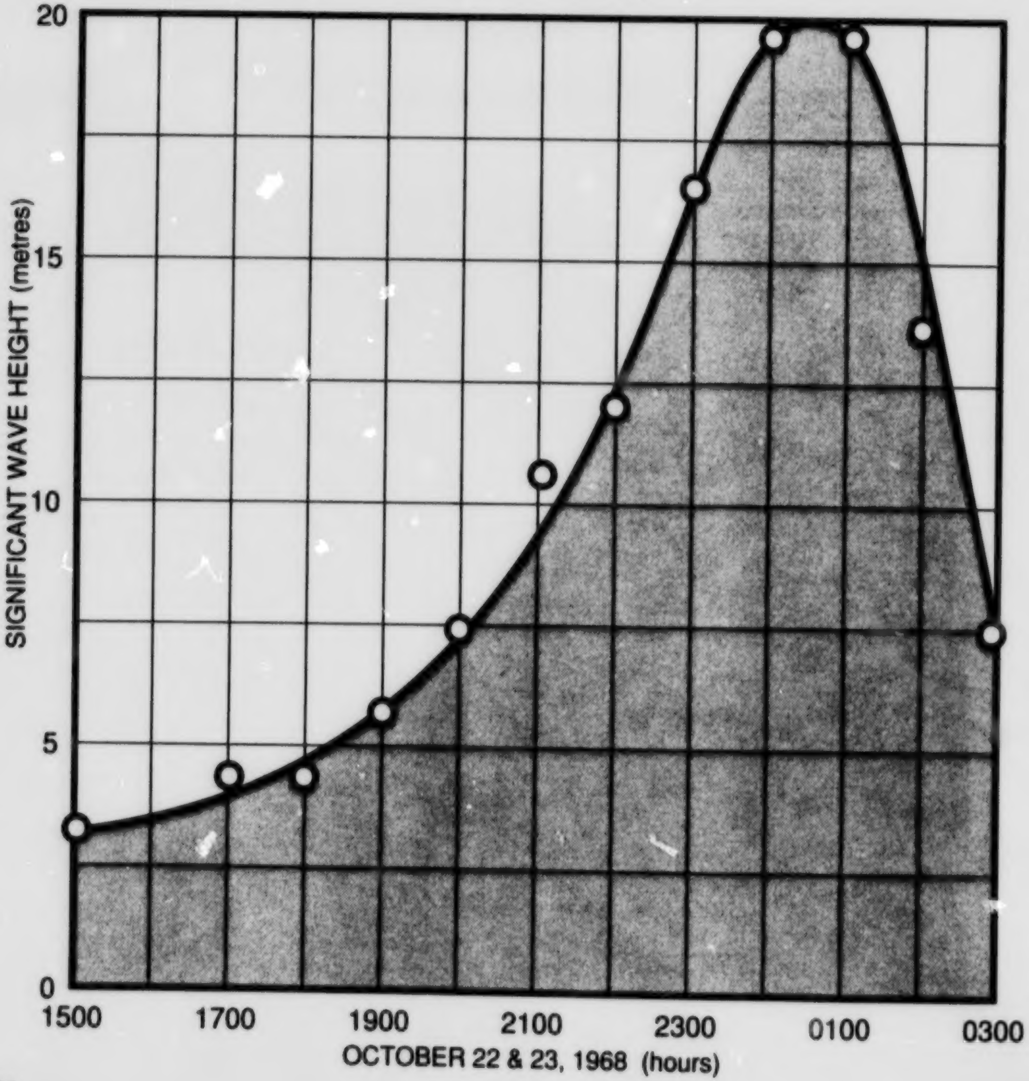


Figure 68. Wave heights observed by SEDCO 135F in southern Hecate Strait, October 22-23, 1968 (after James 1969)

	RETURN PERIOD (YEARS) 5	10	25	50	100
AREA 1					
Significant Wave	11.9	13.4	15.5	17.7	19.8
Extreme Wave	21.3	24.1	28.0	31.7	35.7
AREA 2					
Significant Wave	11.6	13.1	15.5	17.4	19.5
Extreme Wave	21.0	23.8	27.7	31.4	35.0
AREA 3					
Significant Wave	12.0	14.0	16.0	18.5	20.5
Extreme Wave	22.0	25.0	29.5	33.0	36.0

AREA 1
50° to 53°N
coast to 134°W

AREA 2
53° to 56°N
coast to 135°W

AREA 3
54°N to coast
coast to 138°W

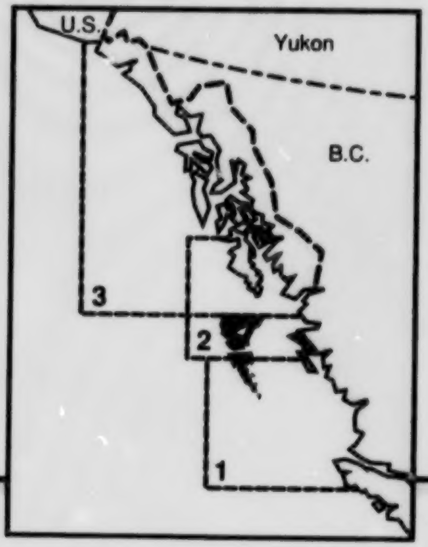


Figure 69 Significant and extreme wave heights calculated for coastal areas of B. C. and southern Alaska (after Quayle & Fulbright 1975 Areas - 1 & 2; Brower et al Areas - 3)

Freak waves, also known as giant or rogue waves, are brief occurrences produced by the synchronization of random waves (Thomson 1981). While of short duration, their danger lies in their total unpredictability. Statistically, 1 wave in 23 should be twice the height of the average wave. The record from Ocean Weather Station PAPA indicates that 20 metre waves are not uncommon in the North Pacific, particularly from November through February. Another dangerous, random wave event is the rip, the result of waves and a current of approximately the same speeds meeting. The danger with rips lies in the fact that they have a very short period and are likely to occur in confined waters where the ocean swell and tidal currents meet.

Tsunamis (often missnamed "Tidal Waves") are a group of waves of long period and wave length generated by an underwater seismic event. While most Tsunamis are associated with strong earthquakes (6.5 or more on the Richter scale), volcanic eruptions, underwater landslides or avalanches into coastal waters can also generate Tsunamis (Anon. 1987b). A submarine slide in April of 1975 near Kitimat is known to have generated a locally destructive wave (Murty & Brown 1979). The largest recorded Tsunami on the west coast of Canada occurred in 1964 as a result of an earthquake in the vicinity of Anchorage, Alaska. It reached 2.4 metres above spring high tide as recorded at Tofino, on Vancouver Island, and it was reported at Shields Bay, on the west coast of Graham Island, to have crested at 5.2 metres above spring high water (Anon. 1982). The destructiveness of the wave at the logging camp there was far less than at the city of Port Alberni, Vancouver Island where the wave reached a height of 2.6 metres.

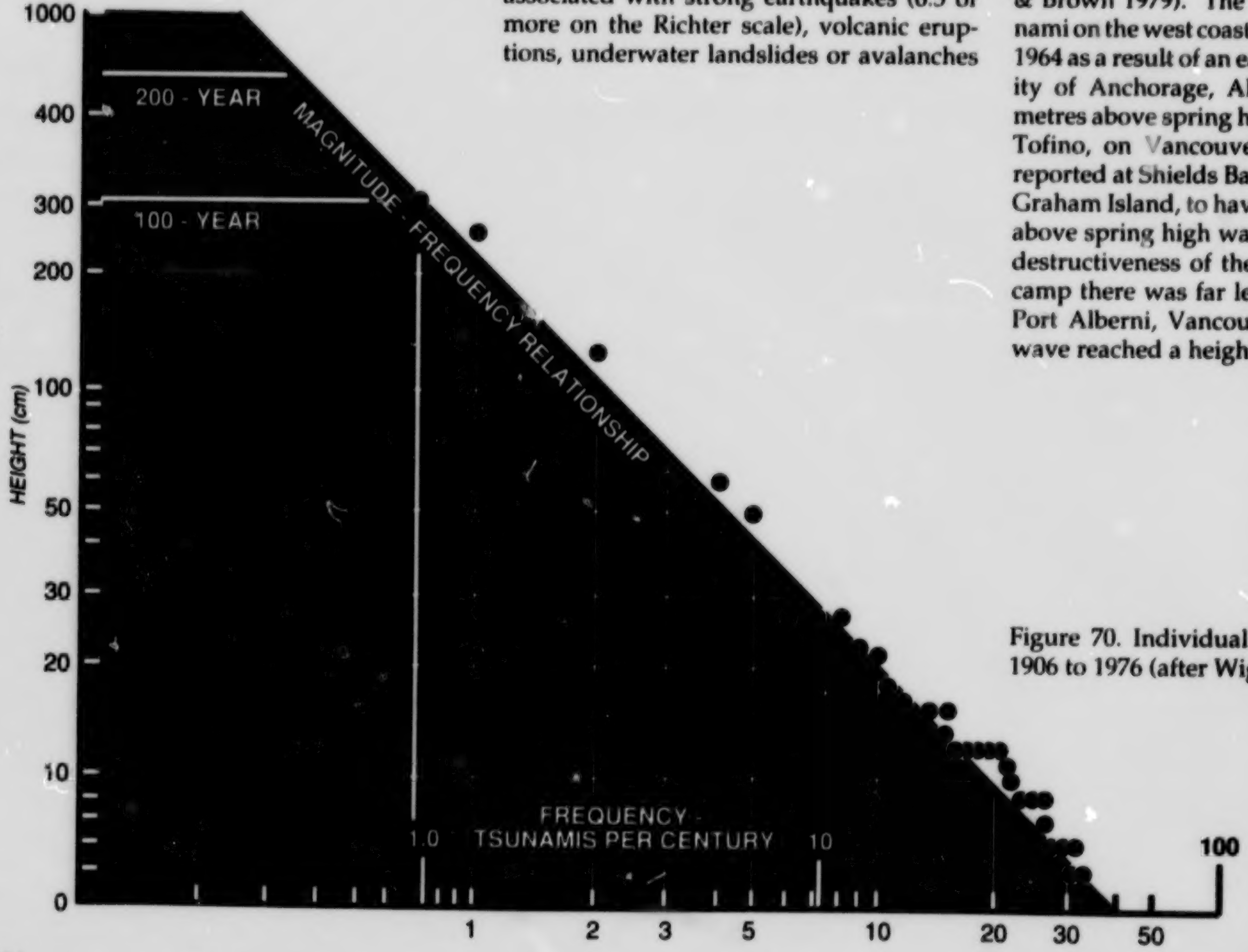
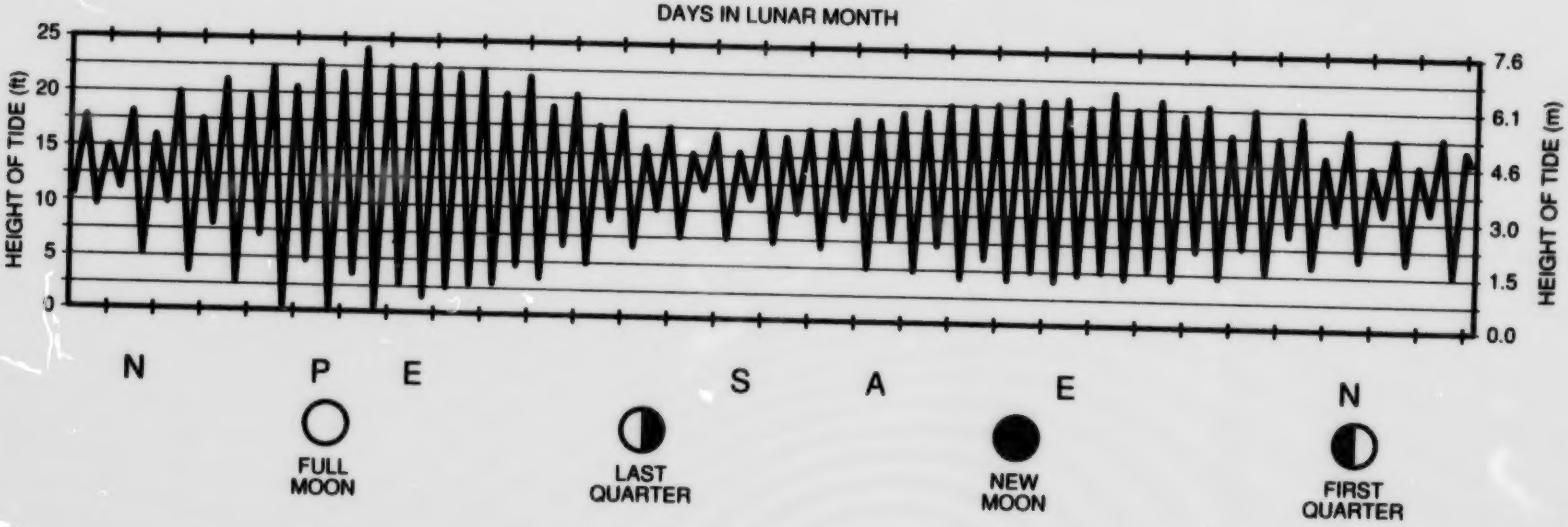


Figure 70. Individual Tsunamis at Tofino, 1906 to 1976 (after Wigen 1979)

TIDES

Within British Columbia's north coastal region, the tides are mixed and predominantly semi-diurnal, having two highs and two lows each lunar day (24.75 hrs), with successive highs and lows of unequal height. Two-week, monthly and seasonal cycles also occur. Tide and current records are provided by 24 tide and current stations on the Queen Charlotte Islands.



A - Moon in apogee; P - Moon in perigee; E - Moon on equator; N - Moon farthest north of equator; S - Moon farthest south of equator

Figure 71. Tides at Prince Rupert (after Canadian Hydrographic Service in Anon. 1983a)

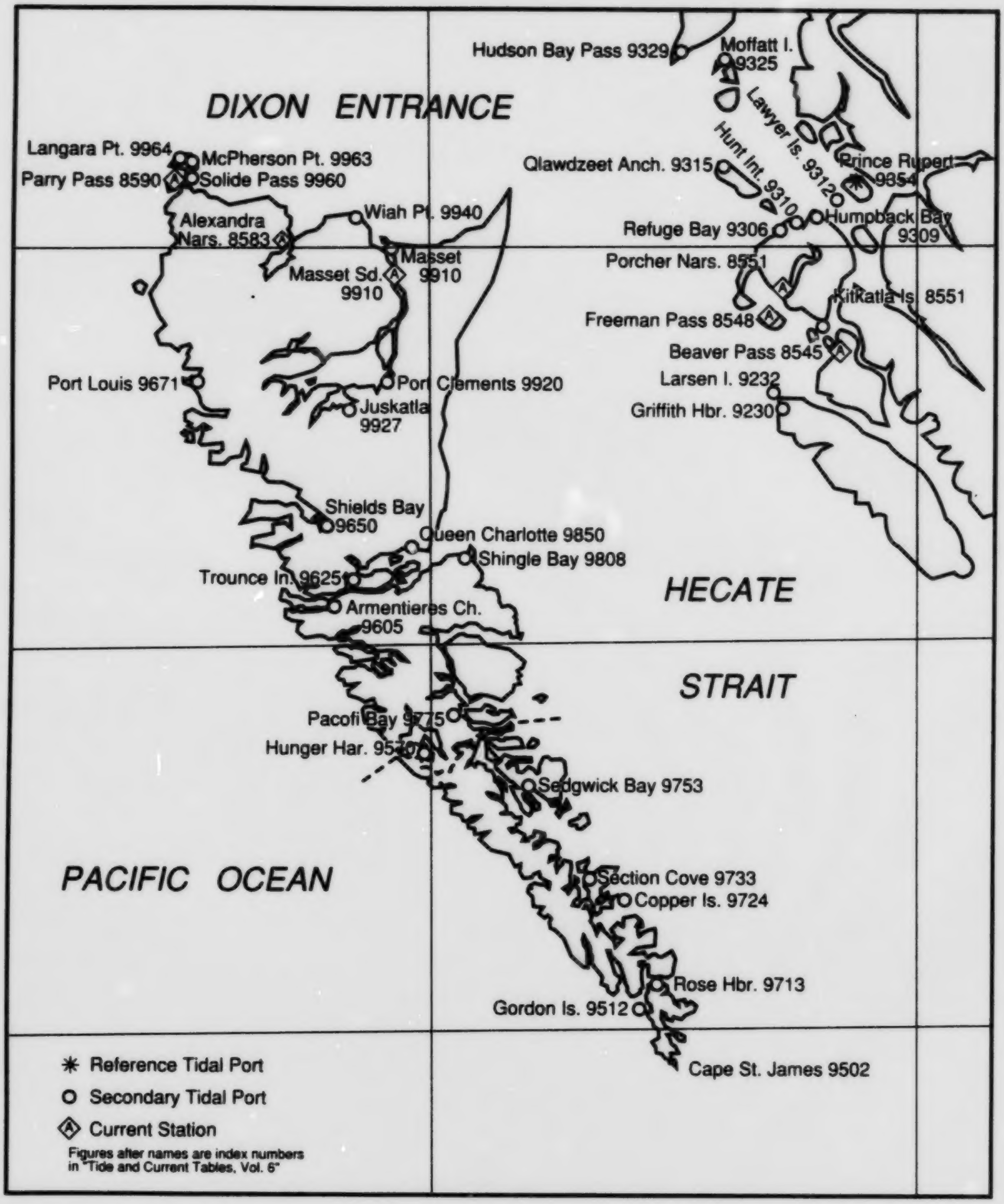

DIXON ENTRANCE
HECATE
STRAIT
PACIFIC OCEAN
Hudson Bay Pass 9329
Moffatt I. 9325
Lawyer Is. 9312
Hunt Int. 9310
Qlawdzeet Anch. 9315
Prince Rupert 9354
Humpback Bay 9309
Refuge Bay 9306
Porcher Nars. 8551
Kitkatla Is. 8551
Freeman Pass 8548
Beaver Pass 8545
Larsen I. 9232
Griffith Hbr. 9230
Langara Pt. 9964
McPherson Pt. 9963
Parry Pass 8590
Solide Pass 9960
Alexandra Nars. 8583
Wiah Pt. 9940
Masset 9910
Masset Sd. 9910
Port Louis 9671
Port Clements 9920
Juskatla 9927
Shields Bay 9650
Queen Charlotte 9850
Shingle Bay 9808
Trounce In. 9625
Armentieres Ch. 9605
Pacofi Bay 9775
Hunger Har. 9530
Sedgwick Bay 9753
Section Cove 9733
Copper Is. 9724
Rose Hbr. 9713
Gordon Is. 9512
Cape St. James 9502
✳ Reference Tidal Port
O Secondary Tidal Port
◈ Current Station
Figures after names are index numbers in "Tide and Current Tables, Vol. 6"

Figure 72. Tide and current stations in the Queen Charlotte Islands (Anon. 1987b)

Due to shoaling, the range of the semidiurnal tide increases from about 2.4 metres at the mouth of Queen Charlotte Sound to about 3.0 metres midway up Hecate Strait, and from 2.4 metres at the mouth of Dixon Entrance to 3.7 metres at its eastern extremity including Chatham Sound (Thomson 1981). Tidal ranges exceed 7 metres in Skidegate Channel and in the vicinity of Prince Rupert. Similarly, the mean tidal range is boosted to as high as 4.9 metres in the movement of the tide up the deep, narrowing channels of the coastal mainland.

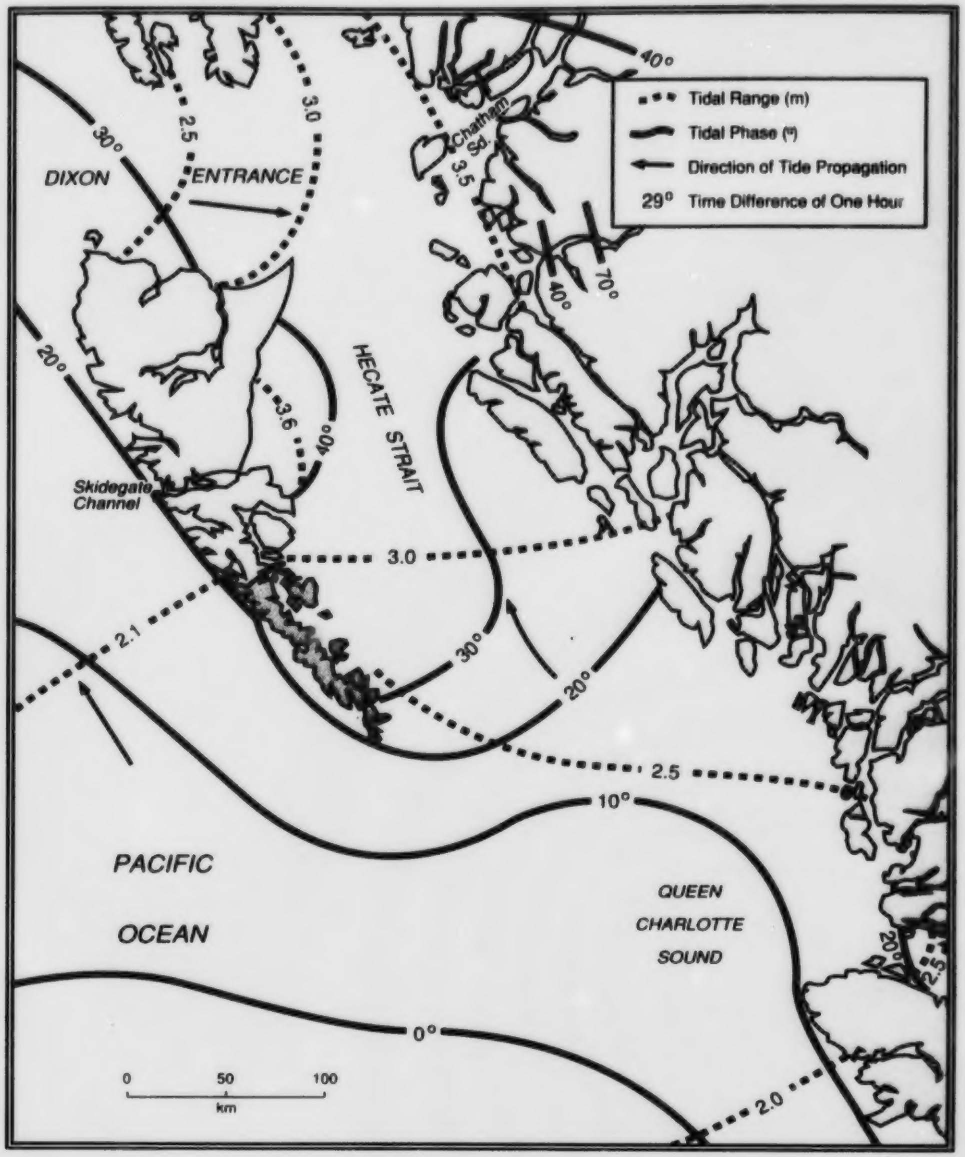
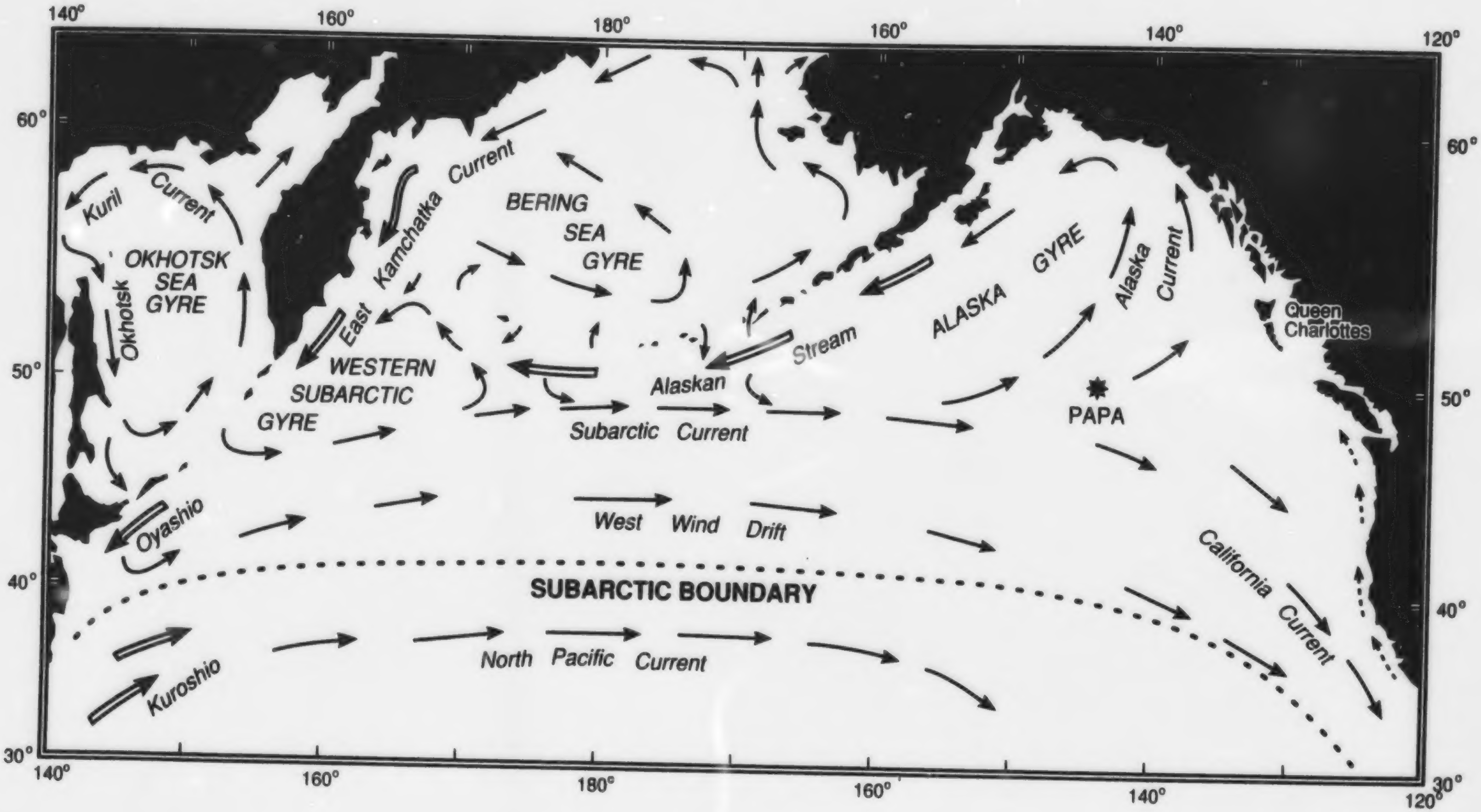

Tidal Range (m)
Tidal Phase (°)
Direction of Tide Propagation
29° Time Difference of One Hour
DIXON
ENTRANCE
HECATE STRAIT
Chatham Sd.
Skidegate Channel
PACIFIC
OCEAN
QUEEN
CHARLOTTE
SOUND
40°
30°
2.5
3.0
3.5
70°
40°
20°
3.6
40°
3.0
2.1
30°
20°
2.5
10°
0°
20°
2.5
2.0
0
50
100
km

Figure 73. Co-range and co-tidal values for the major constituent of the semi-diurnal tide in northern B.C. (after Thomson 1981)

Progress of the tide is rapid. The tide can reach the northern end of Hecate Strait from either of the seaward approaches in about half an hour. The combined tide then proceeds west to reach Graham Island in about a quarter of an hour. Thus, tidal differences are no more than an hour in the protected coastal waters. On the outer coast, a progressive tidal wave moves over the narrow continental margin at approximately 575 km/h, completing the trip from the southern tip of the Queen Charlottes to the northern tip in about 20 minutes.

CIRCULATION

Historically, surface circulatory patterns are thought to have been relatively stable, while the deep ocean circulation may reverse on various time scales (Hay 1988). Present knowledge of offshore circulation is poor in comparison to our knowledge of inshore circulatory mechanisms due not only to the complexity of the open ocean, but to its hostility as well. The general circulatory patterns of the North Pacific Ocean have been described by Thomson (1981) and others (Anon. 1987b; Clague & Bornhold 1980; Dodimead et al. 1963; Doe 1955; Tabata 1975). Mean surface currents affecting the waters off the British Columbia coast are the eastern part of the Alaskan Gyre, a broad, slow, northerly current along the coast which is an extension of the Subarctic Current. West of Vancouver Island, the Subarctic Current splits into the northward-flowing Alaska Current and the southward-flowing California Current. The latitude at which the separation occurs moves farther south in the winter. Off Dixon Entrance, the flow is generally northward.



140°
160°
180°
160°
140°
120°
60°
50°
40°
30°
Kuril
Current
OKHOTSK
SEA
GYRE
Okhotsk
Kamchatka
Current
East
WESTERN
SUBARCTIC
GYRE
BERING
SEA
GYRE
Alaskan
Stream
ALASKA
GYRE
Alaska
Current
Queen
Charlottes
PAPA
Subarctic Current
Oyashio
West Wind Drift
SUBARCTIC BOUNDARY
California Current
Kuroshio
North Pacific Current

Figure 74. Schematic diagram of prevailing surface currents in the north Pacific Ocean. Double arrows are intense boundary currents speeds, typically 1 - 2 m/s (2 - 4 kn); over most of the region speeds are less than 0.25 m/s (0.5 kn). The Subarctic boundary separates the Pacific Region to the north from the Subtropic Pacific Region to the south. Broken arrows correspond to the winter Davidson Current off the Oregon-Washington coast. The former position of ocean weather station PAPA is also indicated. (after Thomson 1981)

Narrow, variable, surface currents predominate over the Continental Shelf and slope. The Davidson Current is a winter season phenomenon, thought to be an extension of the California Current, which reaches as far north as Vancouver Island (Gardner 1982a). While there have been no direct measurements made of sub-surface currents off the Queen Charlotte Islands, satellite thermal imagery has shown a narrow, warm current, named the Haida Current by Bill Emery and Richard Thomson, flowing northward over the Continental slope from northern Moresby Island to the southern part of the Alaska panhandle (Thomson 1989).

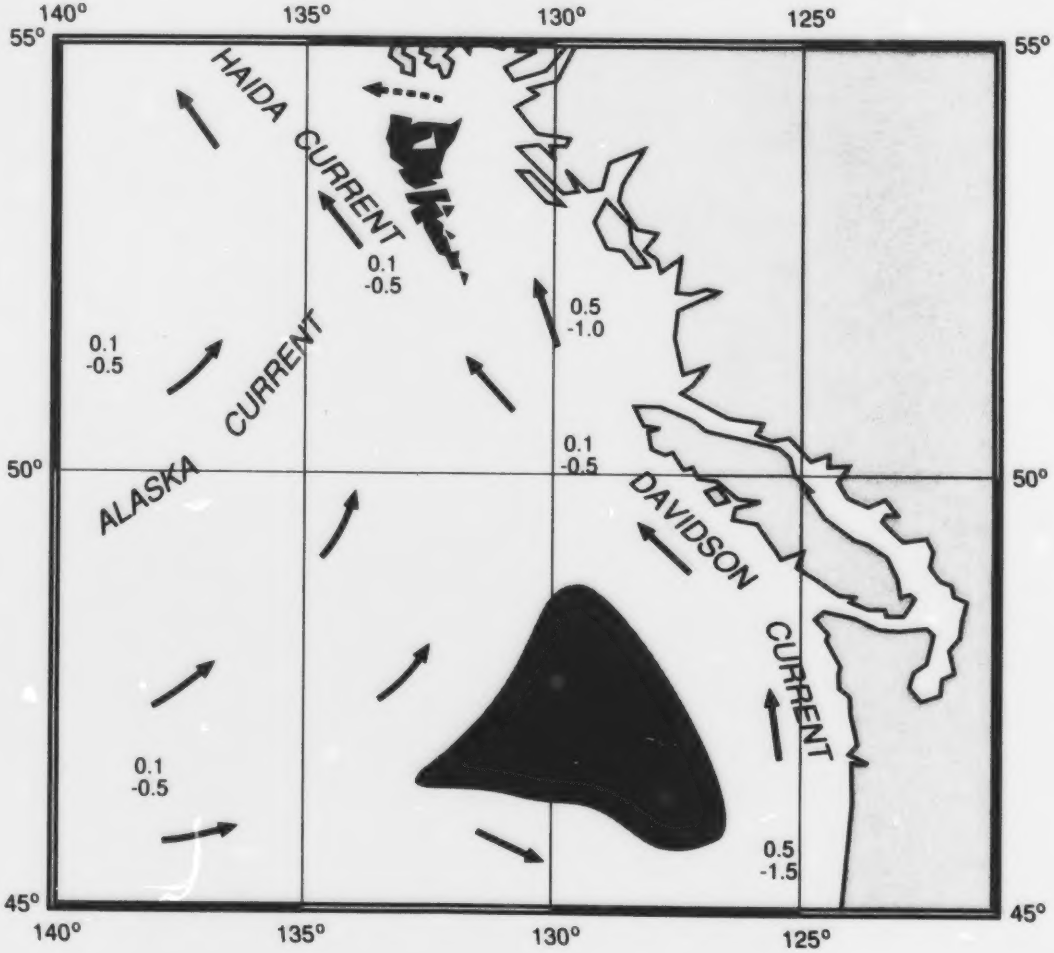

140°
135°
130°
125°
55°
50°
45°
HAIDA CURRENT
ALASKA CURRENT
DAVIDSON CURRENT
0.1
-0.5
0.1
-0.5
0.5
-1.0
0.1
-0.5
0.1
-0.5
0.5
-1.5

Figure 75. General winter circulation (mean drift in knots) off the west coast. Arrows indicate prevailing currents and dotted arrows indicate weak and variable currents. Dark shading indicates general location of confused and variable currents. (after Anon. 1987b)

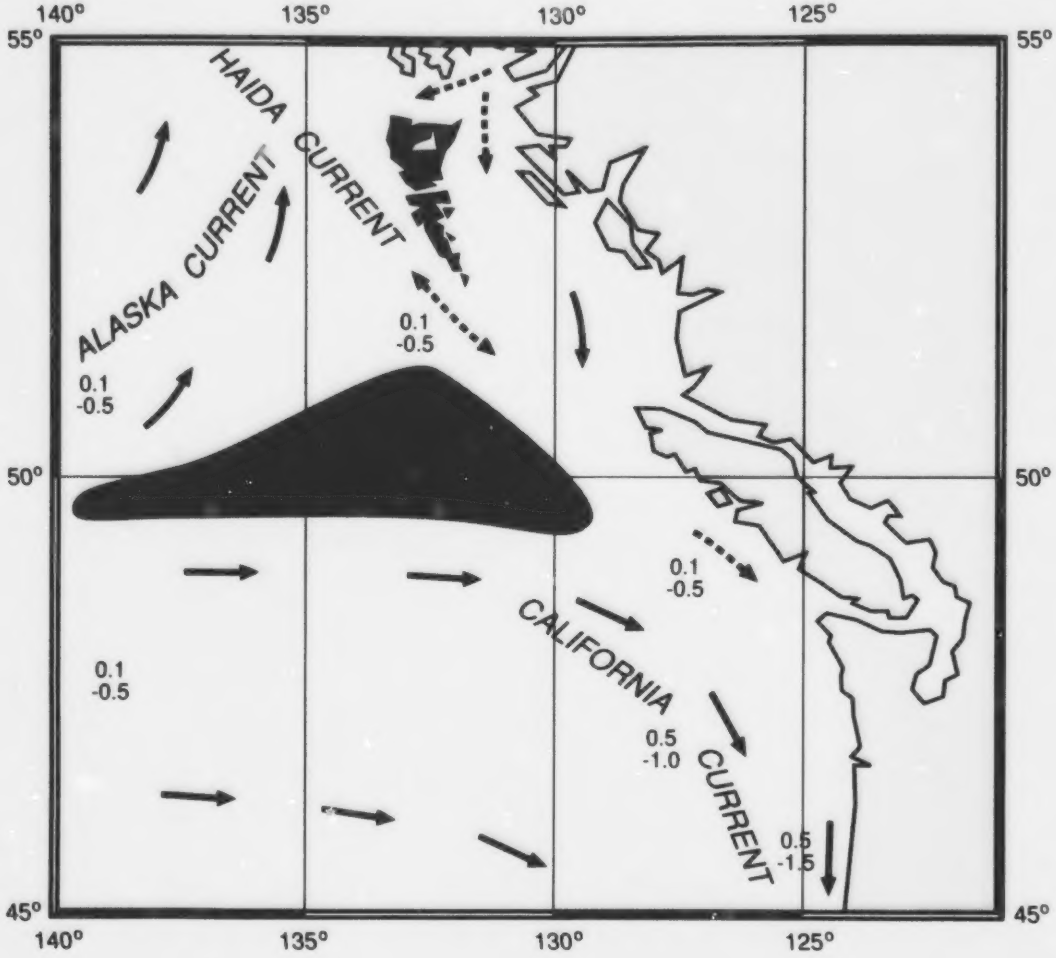


Figure 76. General summer circulation (mean drift in knots) off the west coast. Arrows indicate prevailing currents and dotted arrows indicate weak and variable currents. Dark shading indicates general location of confused and variable currents. (after Anon. 1987b)

Surface circulation within the coastal waters of Dixon Entrance, Hecate Strait, and Queen Charlotte Sound is dominated by the semidiurnal tidal streams, which are in turn affected by wind, runoff, bathymetry, and shoreline configuration (Thomson 1981). Consequently, this circulation is not part of a loop initiated by the northward flow of the Alaskan Gyre. At certain times of the year, particularly during the spring and summer, wind-generated currents and freshwater estuarine outflow may create a persistent ebb bias in the surface flow. In the absence of such influence, oceanic surface streams in Dixon Entrance and Queen Charlotte Sound are clockwise, rotary oceanic tidal streams which change direction about each 12.5 hours. In Hecate Strait, where flow across the channel is restricted somewhat by the bathymetry, tidal streams tend to move parallel to the axis of the channel. There is a strong, northwesterly ebb flow and a weaker, southerly flood. A complex situation exists in Dixon Entrance whereby strong flood streams on the south side and strong ebb streams on the north side create a counter-clockwise gyre.

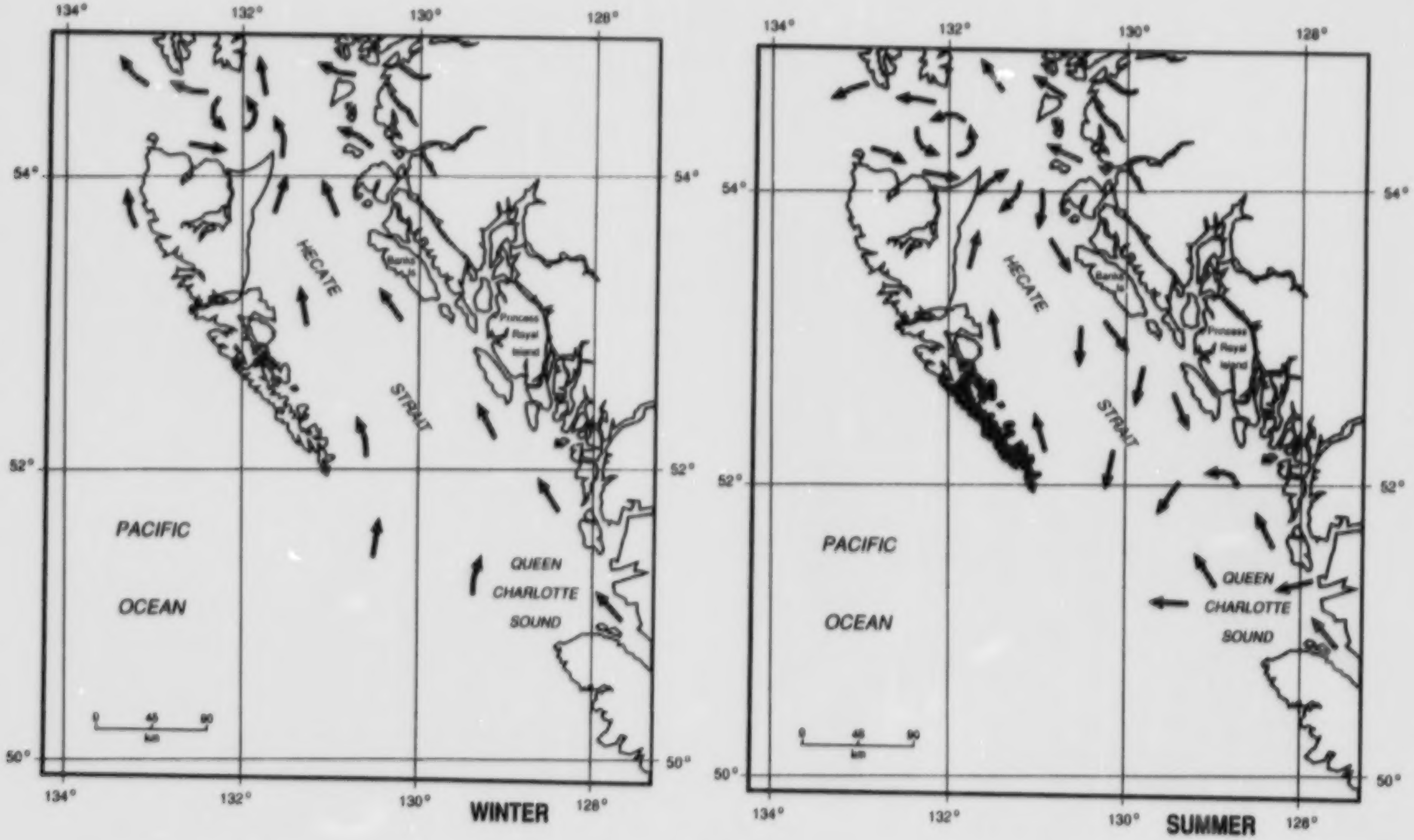

134°
132°
130°
128°
54°
52°
50°
HECATE
STRAIT
Banks Is.
Princess Royal Island
PACIFIC
OCEAN
QUEEN
CHARLOTTE
SOUND
0
45
90
km
WINTER
SUMMER

Figure 77. Surface circulation in British Columbia coastal waters. (after Jamieson et al. 1982)

Estuarine circulation deserves special consideration not only because of its profound effect on predominant circulatory patterns in coastal waters, but because of the great biological importance of estuaries. Acting as a nutrient trap for river-borne organic and inorganic materials, estuaries support the most biologically productive of ecosystems. A wide variety of marine and amphibious fauna rely upon those systems through part or all of their lifespans. Seaward motion and mixing of freshwater speeds seaward surface flow, while a slower landward flow works beneath. While this two-dimensional flow pattern holds true in an inlet, there is more of a three-dimensional flow in a broad-shelf, nearshore region such as Dixon Entrance wherein the seaward flow of brackish water is in the nothern half of the channel while the landward flow is in the southern half (Thomson 1989). The most well-defined estuarine circulation in the Queen Charlotte Islands area is in Eastern Dixon Entrance and Chatham Sound which are influenced by runoff from the Nass and Skeena Rivers (Thomson 1981). Queen Charlotte Sound and Hecate Strait, being far more open, demonstrate less significant estuarine flow. There, estuarine circulation becomes well-defined only in close proximity to the mainland shore.

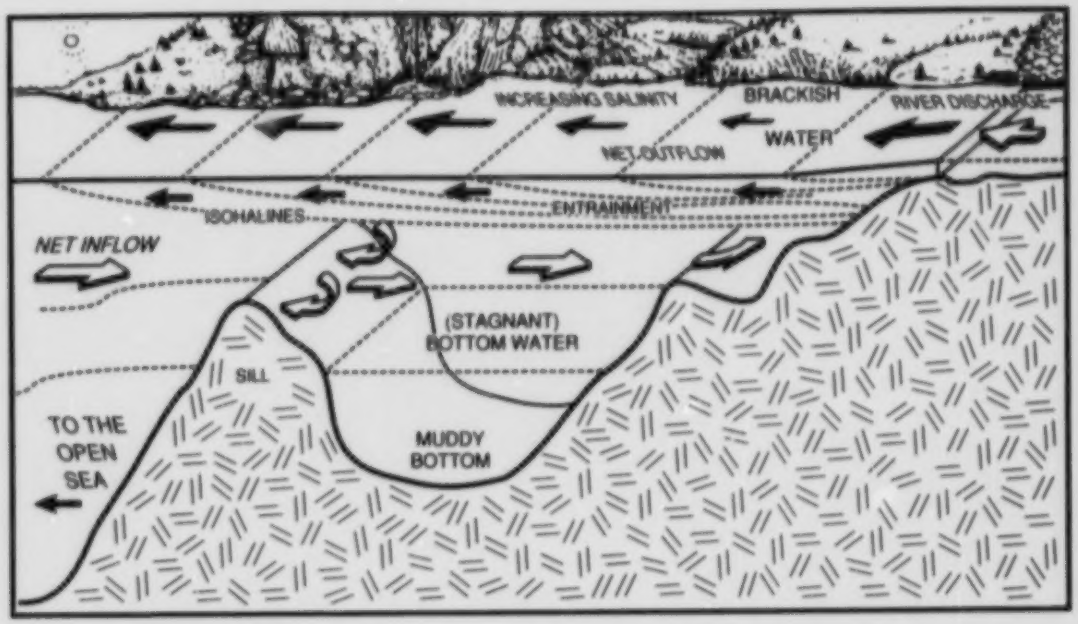
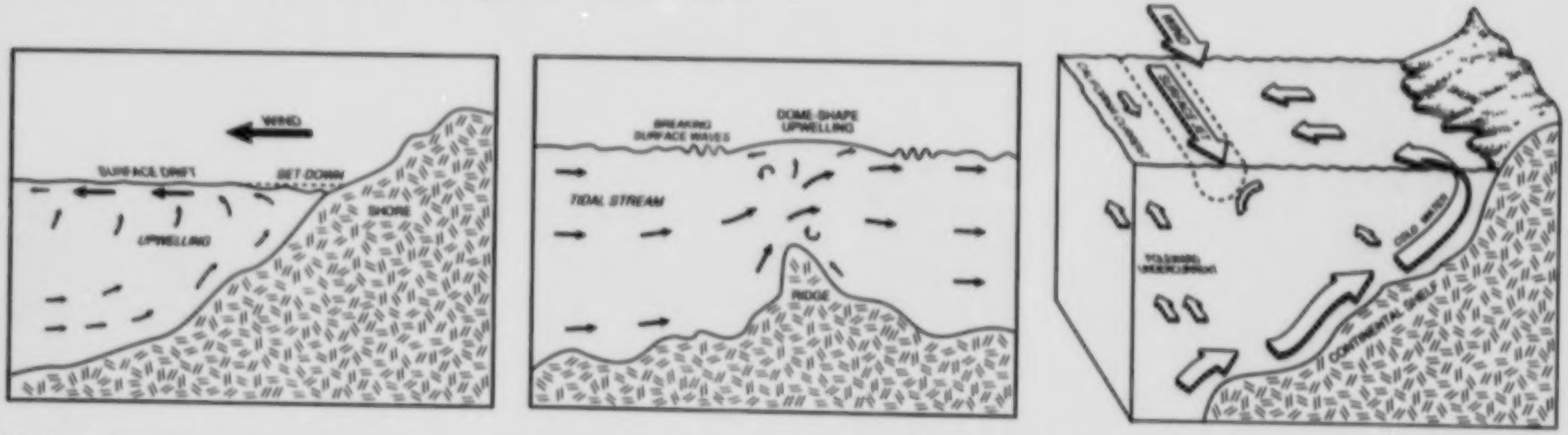


Figure 78. Estuarine circulation in a typical British Columbia inlet. Salt water entrained and carried seaward by river outflow is replenished by a net inflow at depth. Sloping isohalines (lines of equal salinity) indicate a down-inlet increase in salinity in surface brackish layer. Turbulent mixing occurs in vicinity of the sill. (after Thomson 1981)

Upwelling, the movement of cold water from depths of less than 200-300 metres towards the surface, is initiated off the British Columbia coast by summer northwesterly winds (Doe 1955). A weak upwelling occurs off the Queen Charlottes when colder water at depth is forced to rise to replace the warmer surface water which has been pushed away by the wind. On a local level, winds pushing away from a lee shore generate upwelling, as does the deflection of tidal currents by underwater ridges or shoals (Thomson 1981). Upwelling along the boundary between well-mixed and stratified waters in Hecate Strait may account for the high nutrient concentrations in the central portion of the Strait (Perry et al . 1983). Upwelling is weaker and downwelling stronger off Dixon Entrance than off Queen Charlotte Sound (Bakun 1973), though the weak upwelling that does occur off the Queen Charlotte Islands may be important for deep water renewal in Alice Arm at the head of Observatory Inlet (Krauel 1981).

Figure 79. Three mechanisms of upwelling (after Thomson 1981)



Localized upwelling generated along a leeward shore. Set-down is a small drop in mean sea level, the result of net offshore tranport of water.

Upwelling of cooler water produced by deflection of tidal currents over the underwater ridge. Extent and location of upwellings may fluctuate over periods of a few minutes due to variations in current velocity.

Main features of classical wind-induced upwelling in northern hemisphere. Equatorward winds combined with Coriolis force move nearshore surface water offshore; colder subsurface water rises to replace it. Temperature fronts form at confluence of upwelling region (seaward of edge of dashed area). Secondary currents associated with upwelling are strong, narrow equatorward surface jet and weak poleward undercurrent.

Water Properties

Among the most important of water properties are temperature, salinity, density, and turbidity. The content of the water is important, too, in terms of dissolved oxygen, nutrients, trace metals, and hydrocarbons. Having been gathered primarily for fisheries concerns, the bulk of oceanographic information collected in northern British Columbia coastal waters relates to temperature, salinity and dissolved oxygen. Regional reviews by Dodimead (1980) and Tabata (1980), and Birch et al . (1985) summarize the information.

The importance of heat exchange across the air-ocean boundary in determining surface temperatures is readily evident in the winter and summer isothermal patterns in the Pacific Ocean as a whole (Tabata 1976). While largely latitudinal in zonation, the temperature patterns are subject to the perturbations of horizontal and vertical transport, particularly so in summer.

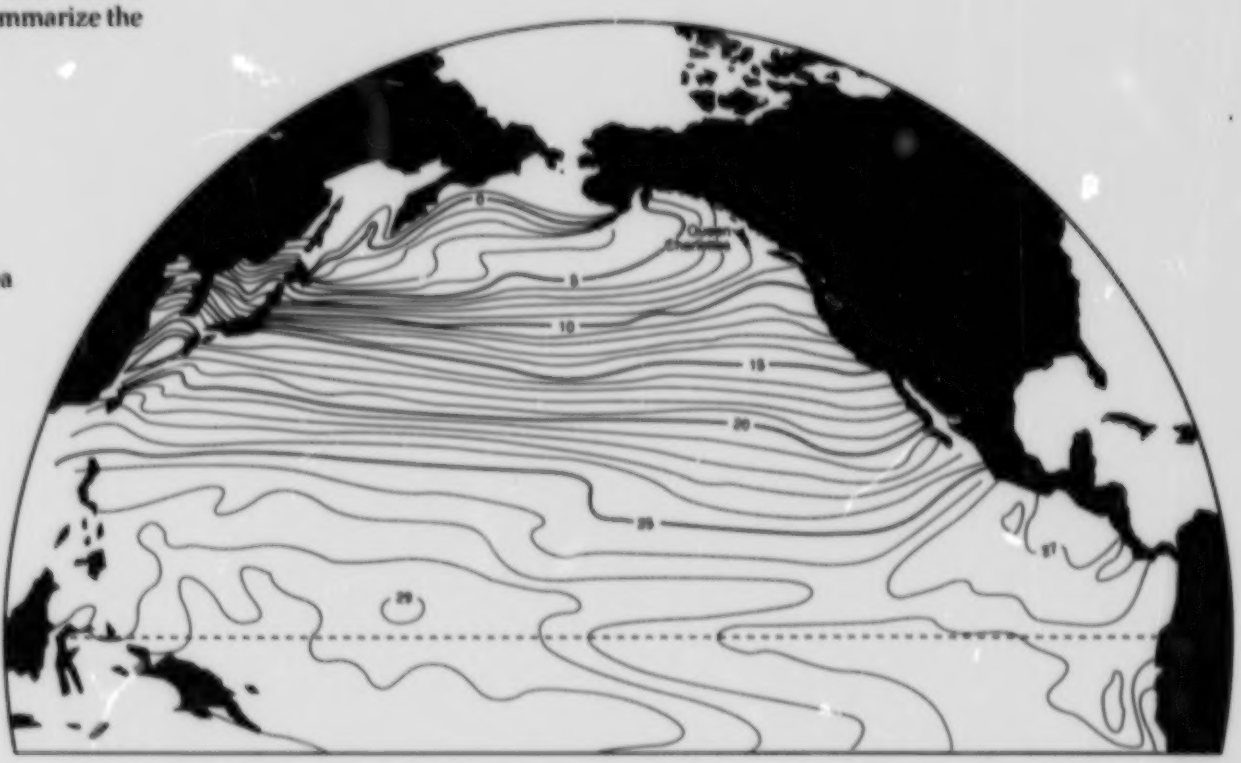
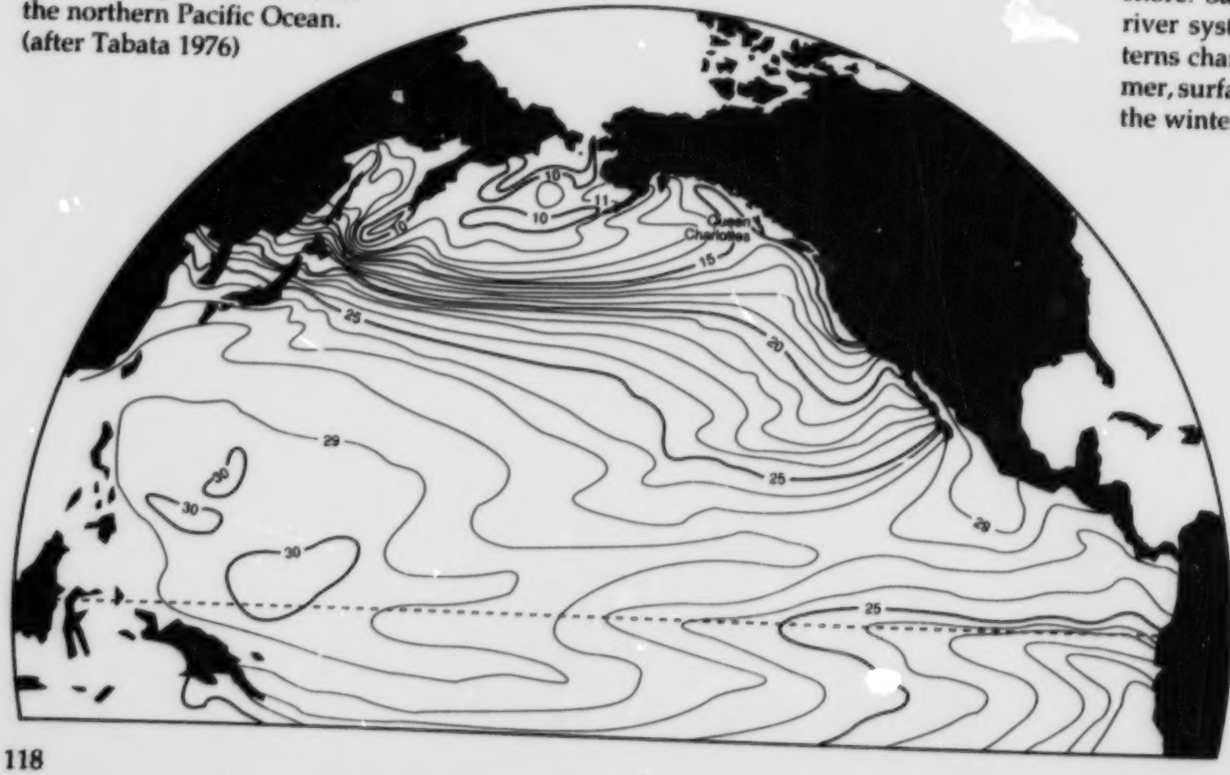


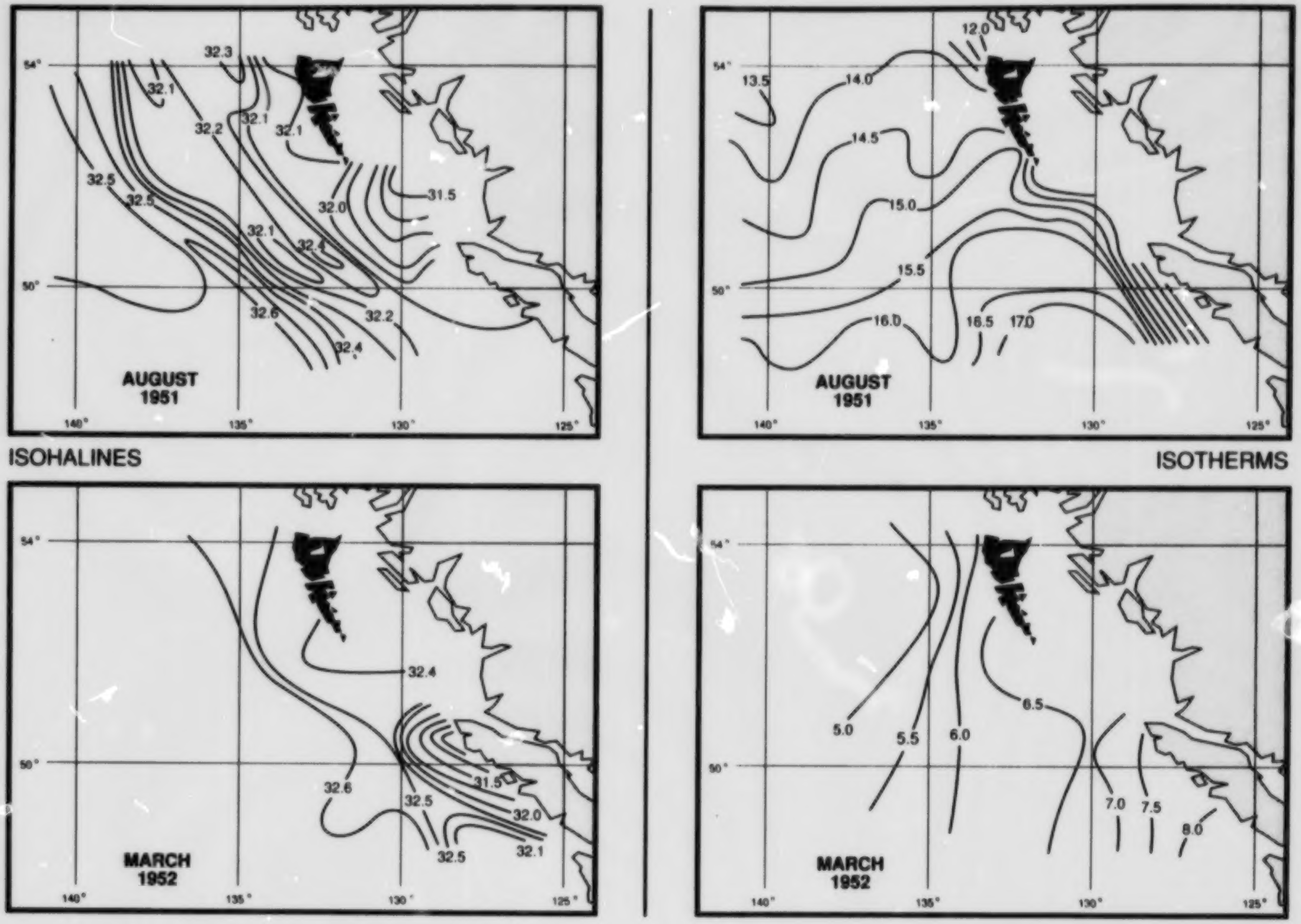
Figure 80. Average February sea surface temperature (°C) for the northern Pacific Ocean. (after Tabata 1976)

Salinity of the open ocean, away from the effects of fresh flowing water, tends to be constant at approximately 32.5 percent (Doe 1955), though there is liable to be some surficial patchiness, with puddles of brackish water surrounded by water of higher salinity (Thomson 1981). Precipitation may be responsible (Royer 1979).

With proximity to the British Columbian coast, both isohalines and isotherms tend to take on a pattern which is parallel to the shore. Salinities decrease as the influence of river systems increases. Temperature patterns change with the seasons. In the summer, surface water warms to seaward, and in the winter surface water cools to seaward.

Figure 81. Average August sea surface temperature (°C) for the northern Pacific Ocean. (after Tabata 1976)





ISOHALINES
ISOTHERMS
AUGUST 1951
MARCH 1952
32.3
32.1
32.2
32.5
32.0
31.5
32.6
32.4
31.5
13.5
14.0
14.5
15.0
15.5
16.0
16.5
17.0
12.0
5.0
5.5
6.0
6.5
7.0
7.5
8.0
54°
50°
140°
135°
130°
125°

Figure 82. Surface isohalines in % salinity and surface isotherms in degrees Celsius, off the British Columbia coast. (after Doe 1955)

Records for coastal surface temperature and salinity from coastal light stations dating back to 1934 reveal the dominance of an annual, solar heating cycle with the highest temperatures being reached in August and the lowest temperatures being reached in March (Thomson 1989). The degree of variation from year to year is high due to a variety of localized processes which include vertical mixing, stratification, varying amounts of runoff, and a range of wind phenomena.

Monthly Averaged Sea SurfaceTemperature,Wind Speed and Air Temperature for Northwest Coastal Waters, 50-55° N

(after Brower et al. 1977).

Month:	Sea Surface: (°C)	Wind Speed: (m/s)	Air: (°C)
January	3-11	6-9	3-6
February	3-11	6-9	4-6
March	2-12	6-9	4-6
April	3-12	6-8	6-8
May	5-14	5-6	8-10
June	7-16	4-6	11-12
July	9-18	4-6	13-15
August	10-20	4-6	14-16
September	9-18	4-7	13-15
October	7-17	5-9	10-14
November	5-14	7-10	6-10
December	4-13	6-10	4-8

Dixon Entrance is consistently colder than Hecate Strait or Queen Charlotte Sound, and the maxima and minima do not occur in August and March, at the beginnings of the respective heating and cooling seasons (Thomson 1981). Instead, wind generated currents drive relatively cold water into Dixon Entrance in the summer, and relatively warm water in the winter. As well, variability in circulation, runoff, mixing and upwelling during the summer make for greater horizontal variation in surface temperature than during the winter in Dixon Entrance (Anon 1983a).

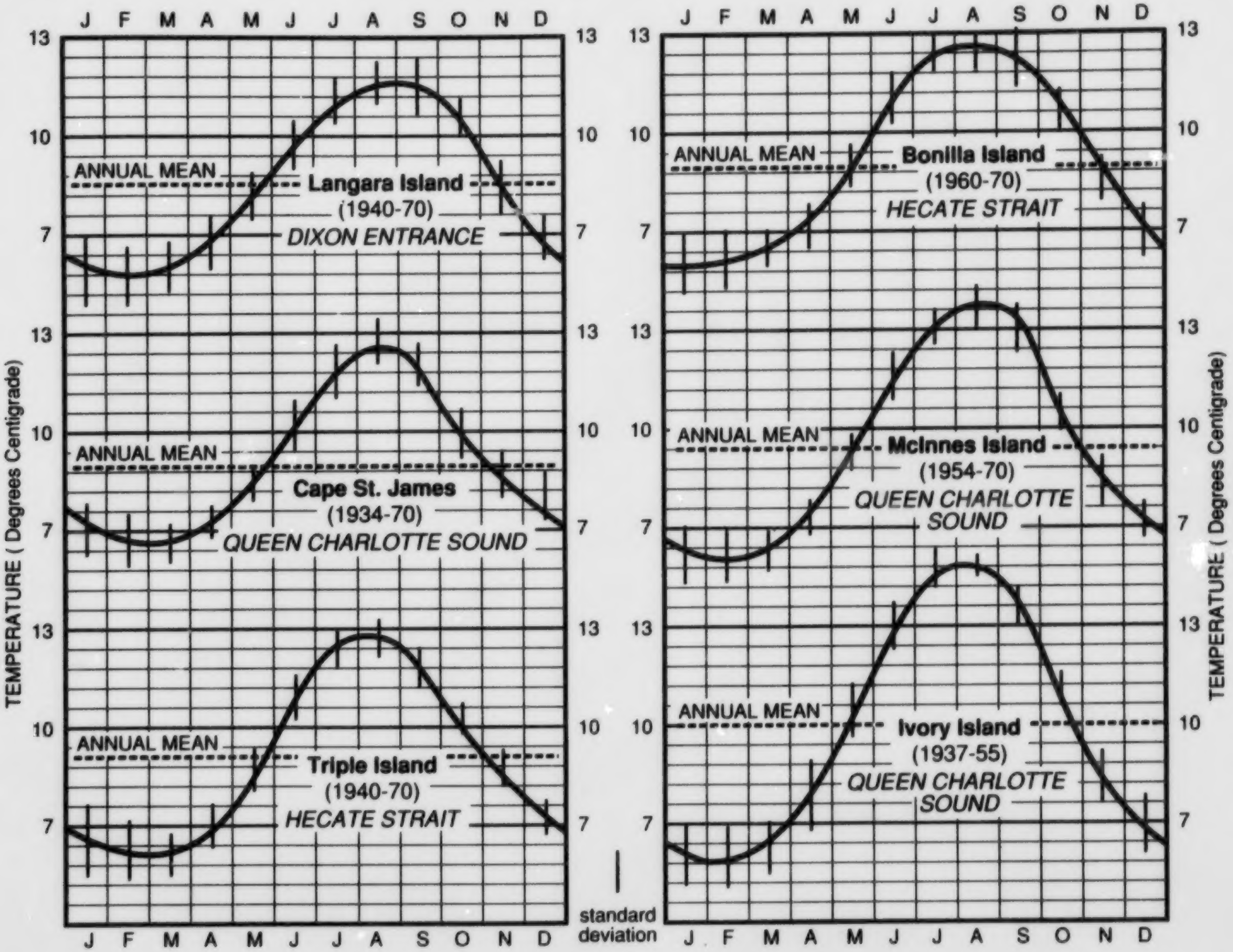


Figure 83. Long term monthly means and standard deviations of sea surface temperature at six lighthouse stations in Dixon Entrance, Hecate Strait and Queen Charlotte Sound (after Dodimead 1980)

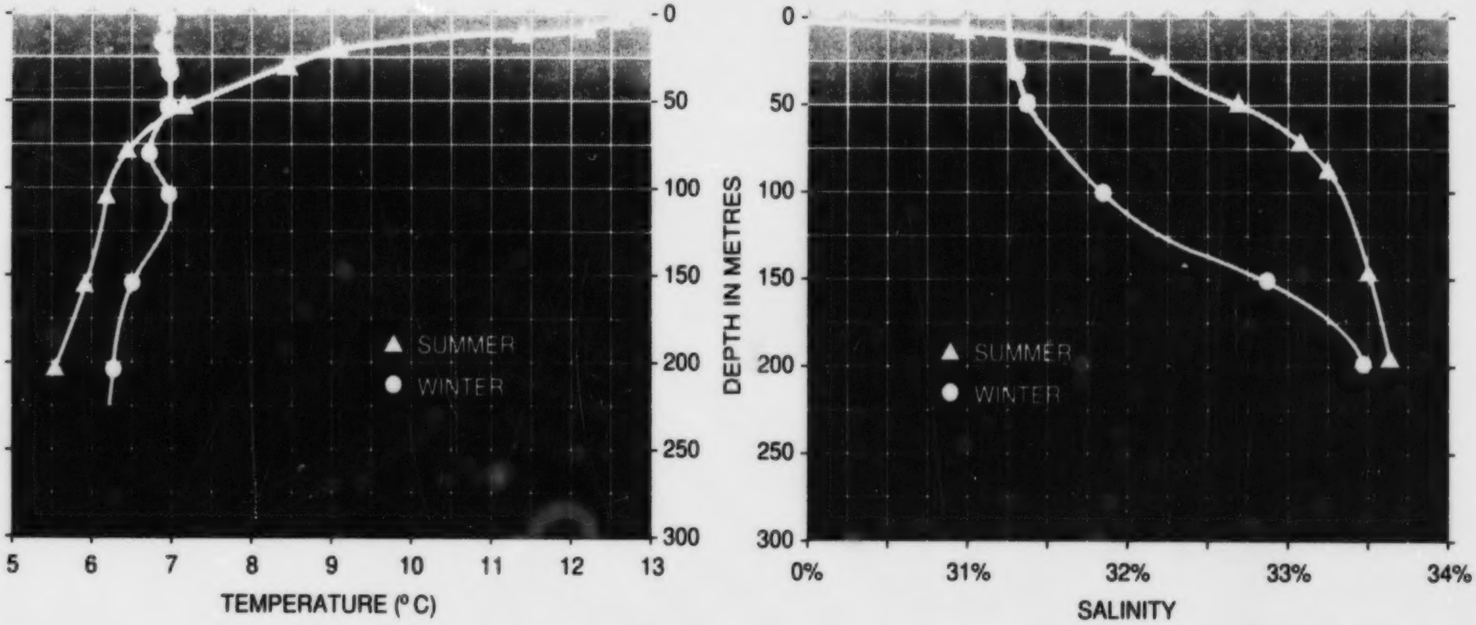


Figure 84. Seasonal vertical temperature and salinity profiles in Dixon Entrance (after Crean 1967)

Variations in sea surface salinity take place over a shorter period than do variations in temperature, nor do the two appear to be linked (Thomson 1989; Webster & Farmer 1976). Salinity records vary with the degree of exposure. The records from exposed oceanic domains such as Langara Island and Cape St. James indicate small annual variations in salinity, Coastal domains such as Triple Island demonstrate large fluctuations as a result of river runoff, and the more sheltered inshore regions such as McInnes Island show the influence of heavy local precipitation. The influences of river mouths and estuaries which affect salinity also affect density (Anon. 1987b). Density varies directly with salinity and inversely with temperature, reaching a maximum in winter and a minimum in summer. Away from the influences of rivers, the annual fluctuations are small.

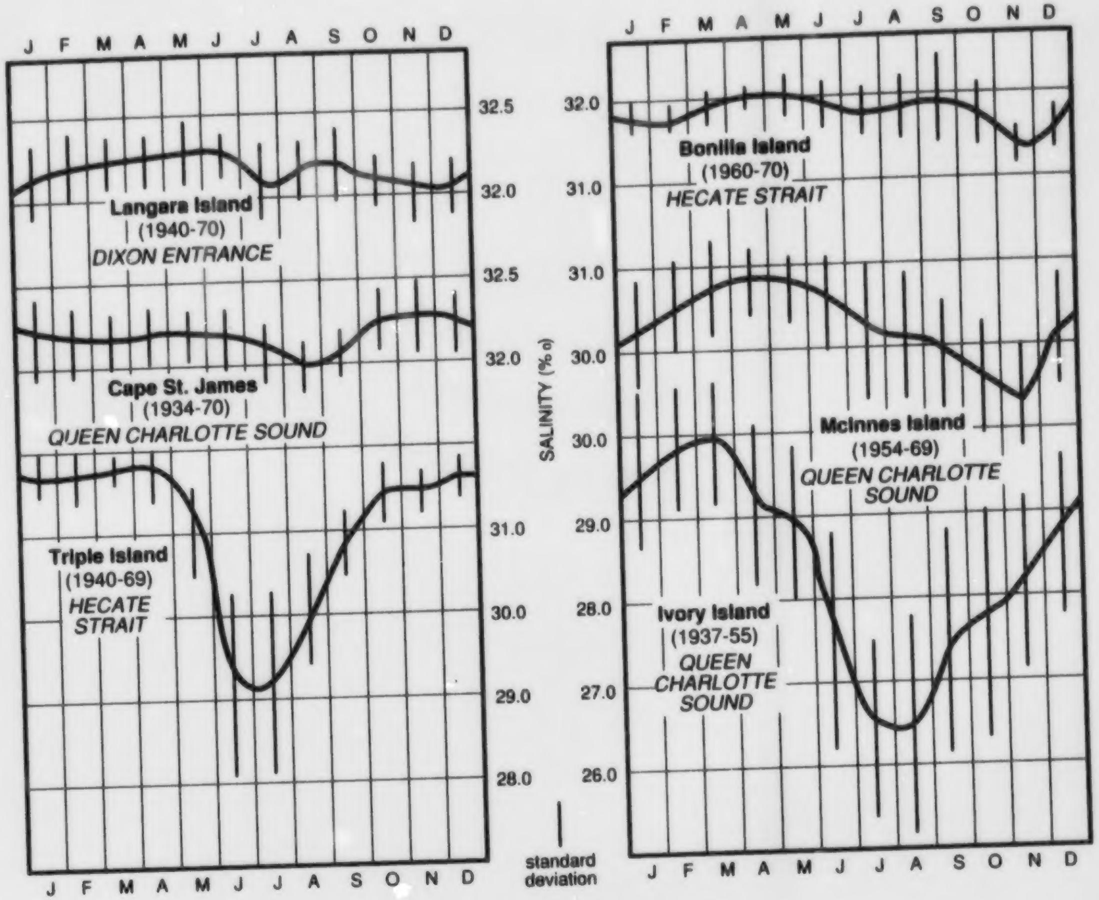


Figure 85. Monthly means and standard deviations of surface salinity at coastal stations in Dixon Entrance, Hecate Strait, and Queen Charlotte Sound (after Dodimead 1980)

Dissolved oxygen levels tend to decrease with depth (Anon. 1983a). At saturation levels (6-10 mL/L) in the upper, wind-mixed layer of water, the oxygen content may be as low as 2 mL/L in cold water brought from depth during summer and fall upwelling. Periods of rapid phytoplanktonic production may see super-saturation of the seawater with oxygen.

Nutrients such as silicates, nitrates and phosphates which are essential for the growth of marine plants vary seasonally in concentration within the upper layers of the ocean where light is sufficient to sustain flora (Anon. 1983a). Depleted in spring and summer by the production of phytoplankton, they are replenished in the fall and winter through vertical mixing. The higher nutrient concentrations in the inshore passages along the coast reflect the influence of freshwater runoff.

Nutrient Concentrations in Dixon Entrance and Hecate Strait
(Perry et al. 1981)

Location:	Silicate: (µg-at/L)	Nitrate-Nitrite: (µg-at/L)	Phosphate: (µg-at/L)
Chatham Sound and Inshore Passages:			
Jan-Feb	65-70	20-25	1-2
April	13-20	5-7	<1
May-June	1-30	0-10	<1
July	10-20	0-10	<1
Dixon Entrance:			
Jan-Feb	-	-	-
April	14-27	8-16	0-2
May-June	3-12	1-4	<1
July	10-20	0-2	<1
East side of Hecate Strait:			
Jan-Feb	17-23	14-22	1-2
April	10-14	3-5	<1
May-June	2-7	<1	<1
July	3-5	<1	<1
West side of Hecate Strait:			
Jan-Feb	10-25	9-17	0-2
April	2-7	0-2	<1
May-June	1-8	<1	<1
July	2-5	<1	<1

Trace metals were measured in sediment samples collected from Hecate Strait in 1979 (Sneddon & Holman 1982). Concentrations measured at six different areas proved much higher than trace metal concentrations reported in 1980 for the North Pacific (McDonald et al .). The concentrations in the North Pacific, which are an indication of the background levels which might be expected in Hecate Strait, measure less than 1 ppb.

Trace Metals in Hecate Strait Sediments (Sneddon & Holman 1982).

Metal	Range of Mean Concentration (ppm)
Aluminum (Al)	6908.9 - 9743.8
Barium (Ba)	18.7 - 29.0
Cadmium (Cd)	1.2 (in one area only)
Chromium (Ch)	12.4 - 22.5
Copper (Cu)	3.5 - 7.4
Iron (Fe)	16 644.4 - 39 971.4
Mercuy (Hg)	0.1 - 0.3
Magnesium (Mg)	295.1 - 5829.3
Manganese (Mn)	187.3 - 334.1
Nickel (Ni)	10.3 - 11.5
Silicon (Si)	2222.2 - 2897.5
Tin (Sn)	25.7 (in one area only)
Strontium (Sr)	86.4 - 517.8
Titanium (Ti)	1293.9 - 2404.4
Vanadium (V)	52.8 - 120.3
Zinc (Zn)	16.0 - 33.2
Molybdenum (Mo)	undetectable
Lead (Pb)	undetectable

Turbidity has traditionally been measured in terms of Secchi disk depth; that is, the depth at which a white, 30 cm diameter disk disappears from view when lowered off the shaded side of a vessel. The range of depths in British Columbia coastal waters is 4-10 metres (Parsons 1965). High runoff rates and high phytoplanktonic production make the summer the period of highest turbidity in coastal areas. Greatest turbidity is in estuaries (Waldichuk et al. 1968). In Dixon Entrance, Secchi disk depths range form a low of 10 metre in the summer, when freshwater discharge is greatest, to a high of 20 metres (Anon. 1983a).

According to a 1976 report (Green), the British Columbia coast was relatively free of hydrocarbon pollution. In the wake of two recent major oil spills in the northwest Pacific Ocean, this is obviously no longer the case, but recent studies have not been completed. Typical concentrations of hydrocarbons are 0.1 to 10 ppb offshore, 10 to 75 ppb in coastal waters, and over 100 ppb in known polluted waters (Vandermeulen 1981).

a) RESOURCE ANALYSIS

While it is not possible to consider the marine water resource as a hydrologic unit in the same way that one can consider the Queen Charlotte Islands themselves to be a hydrologic unit, it is possible to consider a continuum of marine aquatic regions, from the open ocean, to coastal waters, to the very sheltered waters amongst coastal islands and inlets. The distinction is as much one of degrees of shelter as it is one of proximity to and influence by the land mass and its freshwater hydrology.

Studies of the oceanographic resource have been as widely-dispersed, intermittent and lacking in integration as those of the terrestrial resource, if not more so. Realistically, data gathering has been somewhat more complete for the nearshore areas, becoming less comprehensive to seaward. The two major concerns in gathering oceanographic information in the nearshore area have been the safety of mariners and the health of commercial fish stocks. While seasonal patterns of waves, tide and circulation are now identifiable, their vagaries require more intensive study. The studies of water properties to date recognize no dangerous phenomena, but the recent advent of two major oil spills near the northwest coast must have a profound effect on water quality. We must await the outcome of the current analysis of the effects of these two spills to be able to appreciate the present state of water properties on the British Columbia coast. Moreover, the two catastrophies emphasize the need for regular monitoring of ocean water quality.

- MANAGEMENT CONCERNS

Ecological integrity is difficult enough to maintain on land, where access is not hampered by the medium itself and resource management responsibility is vested in the Canadian Parks Service alone, but the marine environment poses restrictions by its very nature, and jurisdiction is shared amongst various interests. Management of the oceanographic resource requires, therefore, that there be not only an intergration of an array of data of varying age and reliability, but that the very process of management itself be integrated.

The problem of integrating the variety of information available on the oceanographic resource is further compounded by the data itself. Having been gathered only since the advent of shipping in the region, and that in various ways and in an irregular manner, the comparability of data is often tenuous. The temporal discontinuity of data gathering and the spatially sporadic efforts at data collection make the task all that more complicated.

There exists only a very fragmentary data base from which to manage the oceanographic resource. What is required by way of remedy and improvement is continuity, not only in temporal and spatial terms, but in terms of the quality of data gathering. This will require a conjoint investment of personnel, funding, and facilities, in an effort to facilitate understanding of the local and regional oceanography on the part of the resource managers of the reserve, if they are to assure the safe enjoyment of the ocean resource by an expanding and increasingly more novice user group.

-STATUS OF KNOWLEDGE

The earliest oceanographic cruise in the area of the Queen Charlotte Islands dates back to 1934 when University of Washington oceanographer T.G. Thompson made observations at three stations across the western entrance to Dixon Entrance, following that up with a second cruise in July 1937 . It was not until May and June of 1938 that J.P. Tully, aboard the MV Amlac, directed the first Canadian oceanographic cruise of the area in Dixon Entrance and Northern Hecate Strait (Dodimead 1980). The first observations of Queen Charlottte Sound and central and southern Hecate Strait took place in 1951 as a precursor to the 1954-55 Hecate Project (Anon. 1955a,b,c). Coastal Surveys were initiated in 1957 (Anon. 1958), and in 1958, the Coastal Seaways Project undertook to address changes in oceanographic conditions from the open ocean to the adjoining coastal seaways of Dixon Entrance, Queen Charlotte Sound and Juan de Fuca Strait (Anon. 1959a,b,c; Herlinveaux et al. 1960). The Coastal Seaways Project was continued in 1960 and 1961 (Lane et al. 1960,1961). Queen Charlotte Sound and Dixon Entrance were again the subject of a major oceanographic study with the prosecution of the Monitor Project in 1961 and 1962 (Crean et al. 1962a,b,c and 1963).

The majority of the older coastal information for British Columbia is that gathered by ships of opportunity on air temperature, sea surface temperature, wind and visibility as early as 1857 (Brown et al. 1986). The British Columbia Shorestation Oceanographic Programme (BCSOP) began in 1914 with surface seawater temperature and density recordings in 1914 at what is now the Pacific Marine Biological Station of the Department of Fisheries and Oceans in Departure Bay, Vancouver Island. But lighthouse stations in the Queen Charlotte region did not begin record keeping until later: Bonilla Island, 1927; McInnes Island 1933; Cape St. James 1947: Langara Island 1948 (Giovando 1988).

Fortunate though we are to have the oceanographic data base that we do, continuity of data gathering has been rare except in the shore station programme and in the work of Ocean Weather Station PAPA which is no longer in existence. Our knowledge of wave action, tides and circulation is better for the coastal region than it is for the offshore. Water properties, other than temperature and salinity, are less well understood than are waves, tides and currents. And while a warning system is in place for Tsunamis, they deserve intensive study due to their potentially catastrophic nature.

b) SELECT REFERENCE SOURCES

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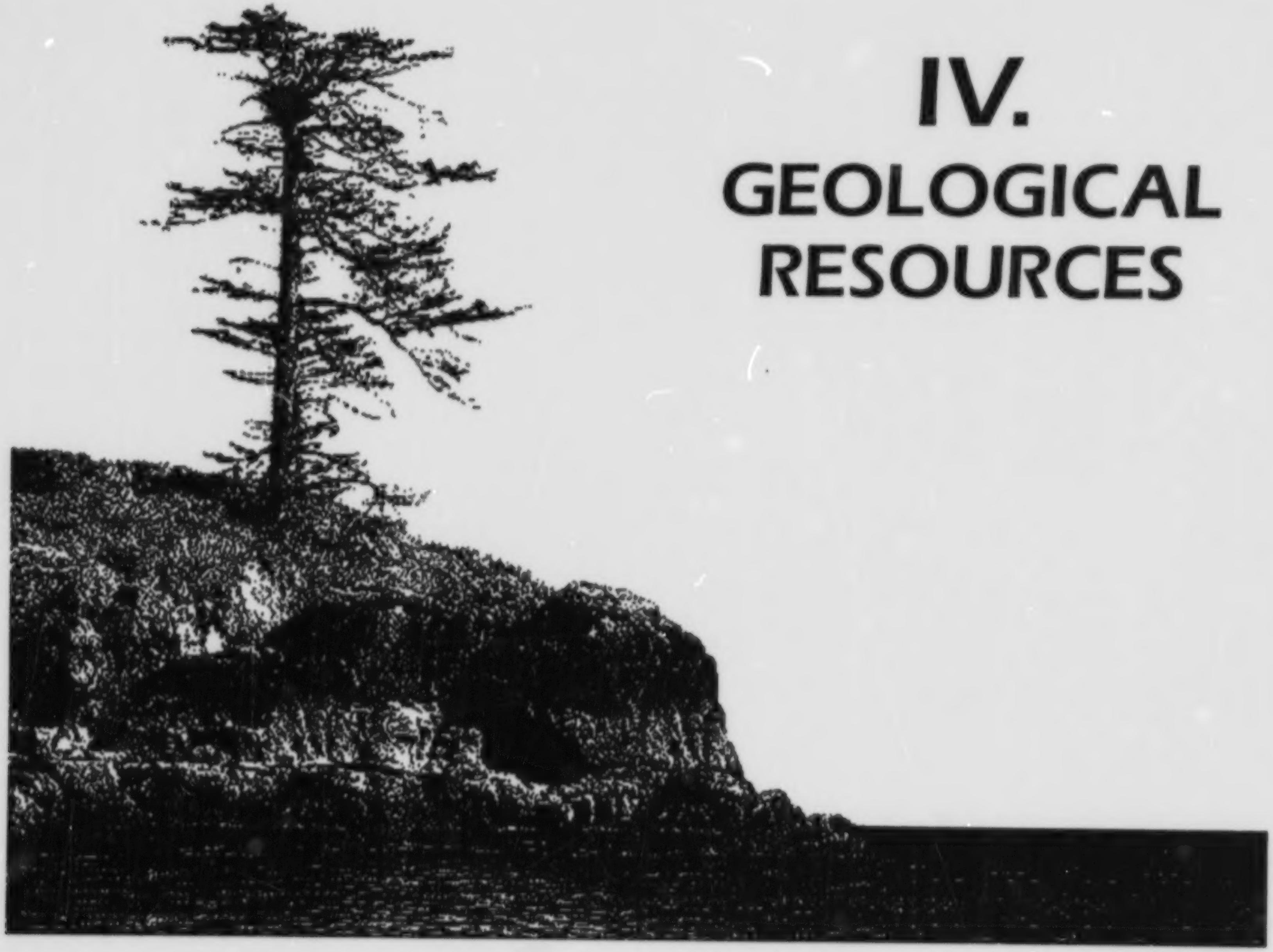


IV.
GEOLOGICAL RESOURCES

GEOLOGICAL RESOURCES

General Overview

The geological resources of the Queen Charlotte Islands can not be separated from the well-described, modern concepts and models about the long orogenic history of development of the western margin of the North American Cordillera (Clowes & Gens-Lenartowicz 1985; Coney *et al.* 1980; Davis & Plafker 1985; Dehler & Clowes 1988; Howell 1985; Hyndman *et al.* 1982; Hyndman & Ellis 1981; Jones *et al.* 1982; Lewis *et al.* 1985; Meyerhoff 1970; Riddihough 1982; Rogers 1988; Tipper *et al.* 1981; Tobin & Sykes 1968; Yorath & Chase 1981; Yorath & Hyndman 1983). That margin is now seen as a collage of blocks and slivers of crustal fragments, referred to as terranes or micro-plates, and brought together by the relentless sea-floor spreading movements of the Pacific Plate and segments of associated plates, and that of the North American Plate (Riddihough 1982). While the plate tectonic history leading to today's configuration of the eastern Pacific began about 280 million years ago, the reconstruction of the plate tectonic events by scientists allows us now to look back with some reasonable understanding of the events, as they might have occurred during the past 120-140 million years.

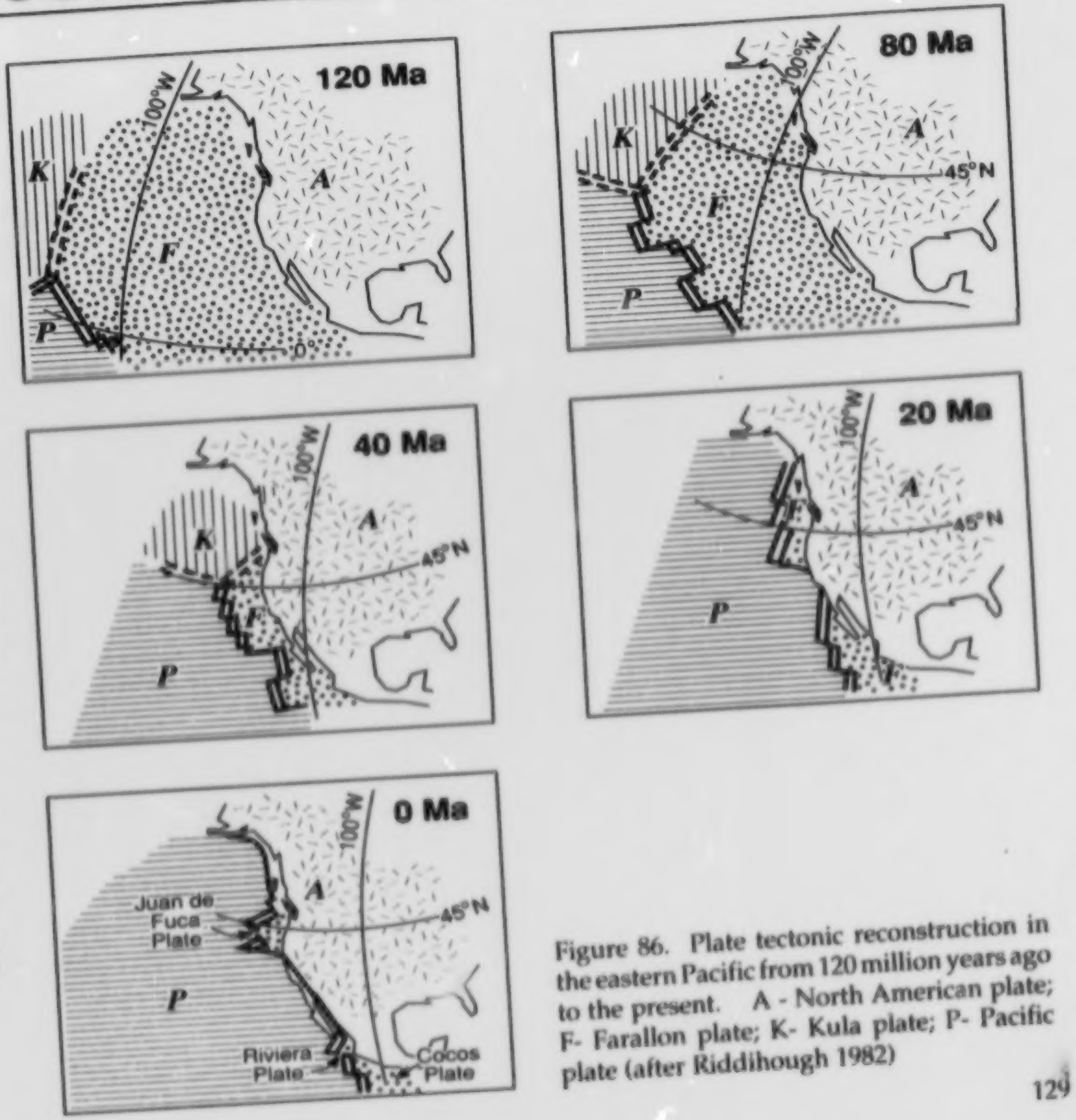


Figure 86. Plate tectonic reconstruction in the eastern Pacific from 120 million years ago to the present. A - North American plate; F- Farallon plate; K- Kula plate; P- Pacific plate (after Riddihough 1982)

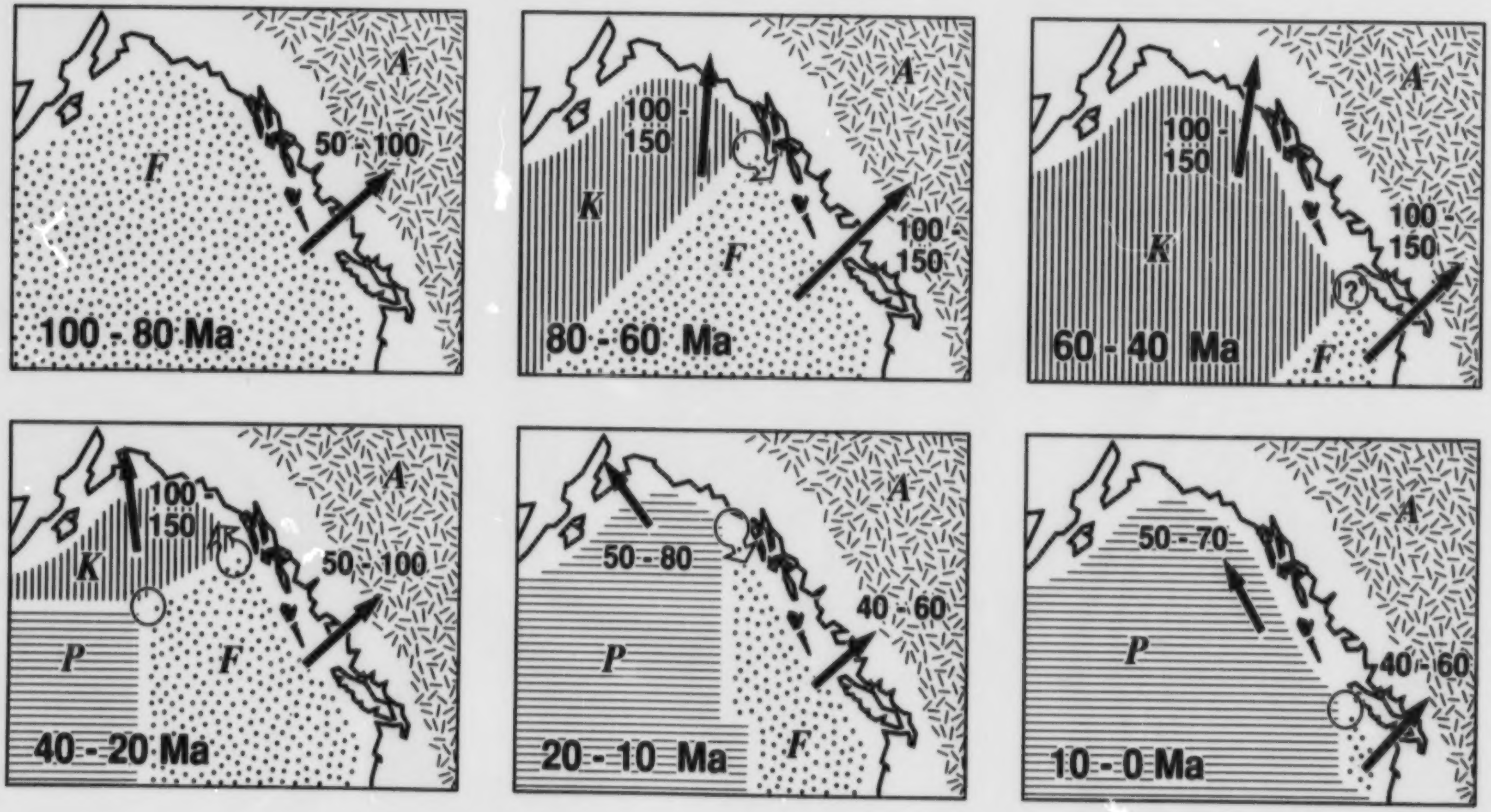

A
F
50 - 100
100 - 80 Ma
A
100 - 150
K
F
100 - 150
80 - 60 Ma
A
100 - 150
K
100 - 150
?
F
60 - 40 Ma
A
100 - 150
K
50 - 100
P
F
40 - 20 Ma
A
50 - 80
P
40 - 60
F
20 - 10 Ma
A
50 - 70
P
40 - 60
10 - 0 Ma

Figure 87. Plate interactions off Western Canada during the last 100 million years from a consensus of plate reconstructions (after Riddihough 1982)
Note: A - North American plate; F - Farallon Plate; K - Kula plate; P - Pacific plate

According to the latest concepts, it has taken the last 100 million years to bring about the present configuration of the continental margin of western Canada by large northward movements and predominantly right-lateral, northwesterly trending strike slip faulting of the tectonic plates involved. Though largely destroyed now by the convergent margin, the once large "Farallon Plate" east of the sea-floor spreading Pacific Rise, and whose remnants are now known along the west coast as the "Juan de Fuca Plate", was over-ridden or subducted along the western margin of North America during the last 100-150 million years. The rate of convergence has been calculated to have been on the average 40 millimetres per year, or 40 kilometres for every million years. During the same period, the "Kula" and "Pacific" Plates west of the Pacific Rise, approached the continental margin in north-easterly trending movements to reach their present position. The Kula Plate is now completely subducted, the Farallon Plate (= Juan de Fuca Plate) very nearly so, and the Pacific Plate lies immediately off the west coast of North America from just south of the Queen Charlotte Islands to the Aleutian Islands (Riddihough 1982).

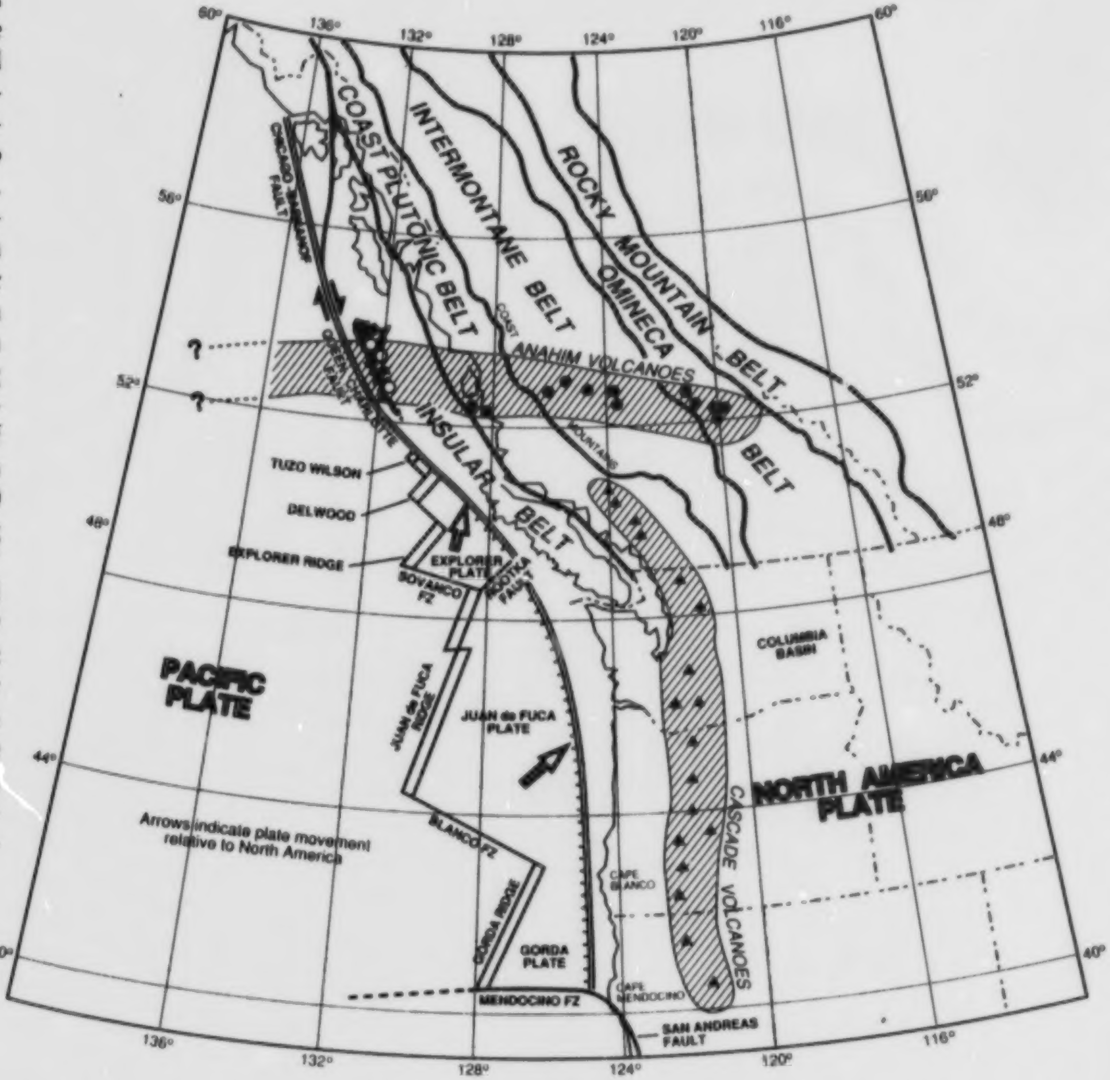

60°
136°
132°
128°
124°
120°
116°
60°
56°
56°
52°
52°
48°
48°
44°
44°
40°
40°
136°
132°
128°
124°
120°
116°
CHICAGO SABANOF FAULT
COAST PLUTONIC BELT
INTERMONTANE BELT
ROCKY MOUNTAIN BELT
OMINECA BELT
COAST
ANAHIM VOLCANOES
MOUNTAINS
QUEEN CHARLOTTE FAULT
INSULAR BELT
?
?
TUZO WILSON
DELWOOD
EXPLORER RIDGE
EXPLORER PLATE
SOVANCO FZ
NOOTKA FAULT
JUAN de FUCA RIDGE
JUAN de FUCA PLATE
PACIFIC PLATE
COLUMBIA BASIN
NORTH AMERICA PLATE
Arrows indicate plate movement relative to North America
BLANCO FZ
GORDA RIDGE
GORDA PLATE
CAPE BLANCO
CASCADE VOLCANOES
CAPE MENDOCINO
MENDOCINO FZ
SAN ANDREAS FAULT

Figure 88. Contemporary tectonic setting of the Queen Charlottes (after Brown & Yorath 1989)

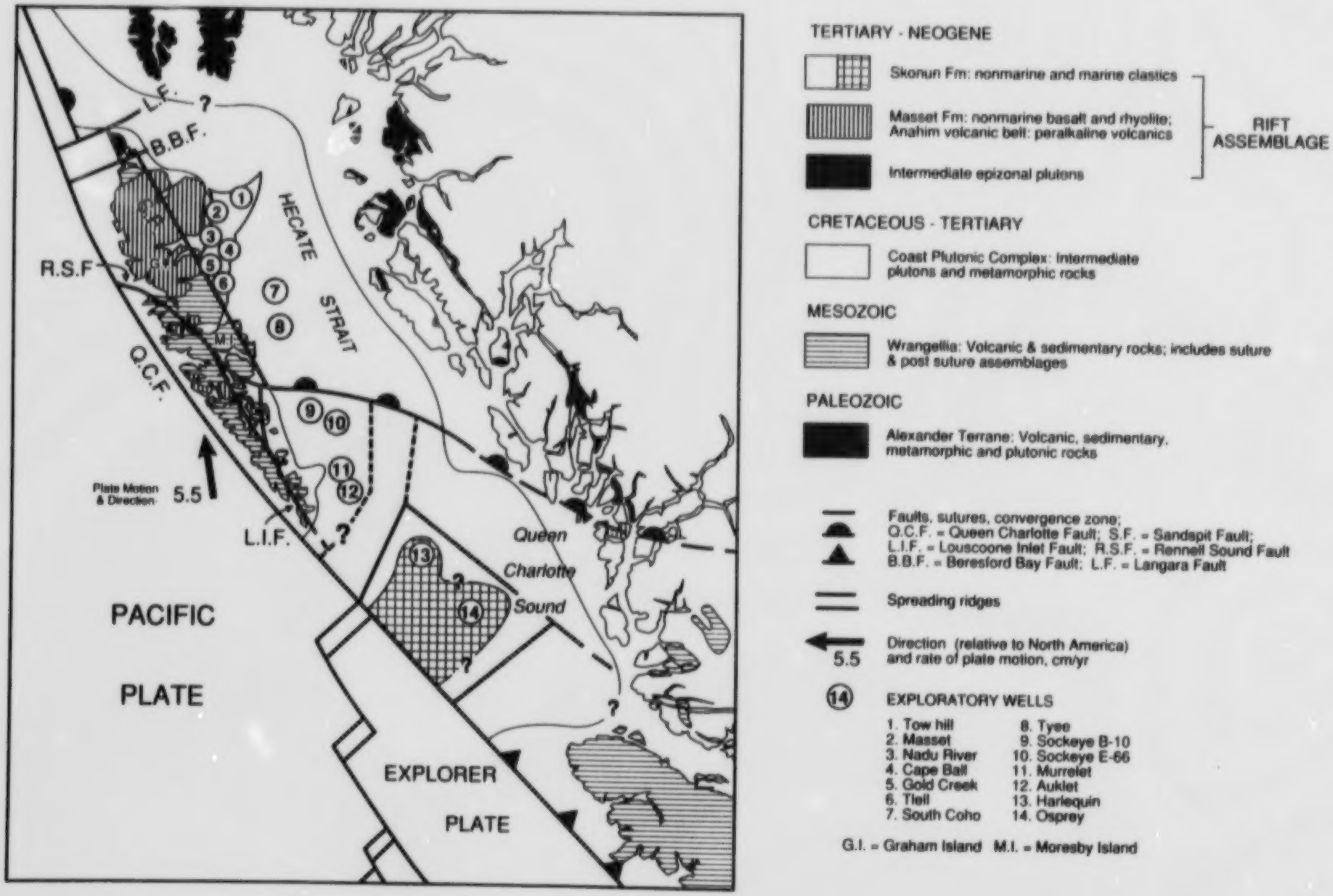

L.F.
?
B.B.F.
R.S.F
Q.C.F.
L.I.F.
?
HECATE STRAIT
M.I.
①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪
⑫
⑬
⑭
Plate Motion & Direction 5.5
PACIFIC PLATE
EXPLORER PLATE
Queen Charlotte Sound
?
?
?
TERTIARY - NEOGENE
Skonun Fm: nonmarine and marine clastics
Masset Fm: nonmarine basalt and rhyolite; Anahim volcanic belt: peralkaline volcanics
Intermediate epizonal plutons
RIFT ASSEMBLAGE
CRETACEOUS - TERTIARY
Coast Plutonic Complex: Intermediate plutons and metamorphic rocks
MESOZOIC
Wrangellia: Volcanic & sedimentary rocks; includes suture & post suture assemblages
PALEOZOIC
Alexander Terrane: Volcanic, sedimentary, metamorphic and plutonic rocks
Faults, sutures, convergence zone;
Q.C.F. = Queen Charlotte Fault; S.F. = Sandspit Fault;
L.I.F. = Louscoone Inlet Fault; R.S.F. = Rennell Sound Fault
B.B.F. = Beresford Bay Fault; L.F. = Langara Fault
Spreading ridges
5.5
Direction (relative to North America) and rate of plate motion, cm/yr
⑭
EXPLORATORY WELLS
1. Tow hill
2. Masset
3. Nadu River
4. Cape Ball
5. Gold Creek
6. Tlell
7. South Coho
8. Tyee
9. Sockeye B-10
10. Sockeye E-66
11. Murrelet
12. Auklet
13. Harlequin
14. Osprey
G.I. = Graham Island M.I. = Moresby Island

Figure 89. The present tectonic configuration, with apparent plate motion and direction, & locations of exploratory wells (after Brown & Yorath 1989)

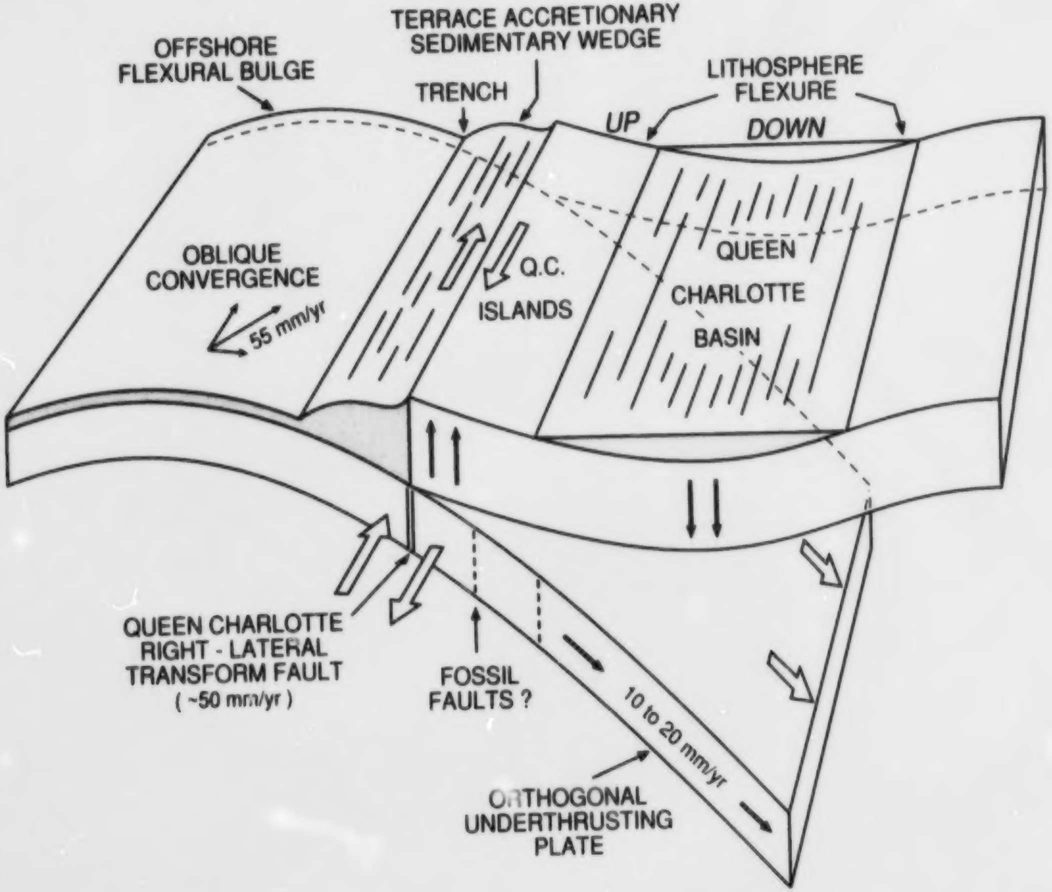
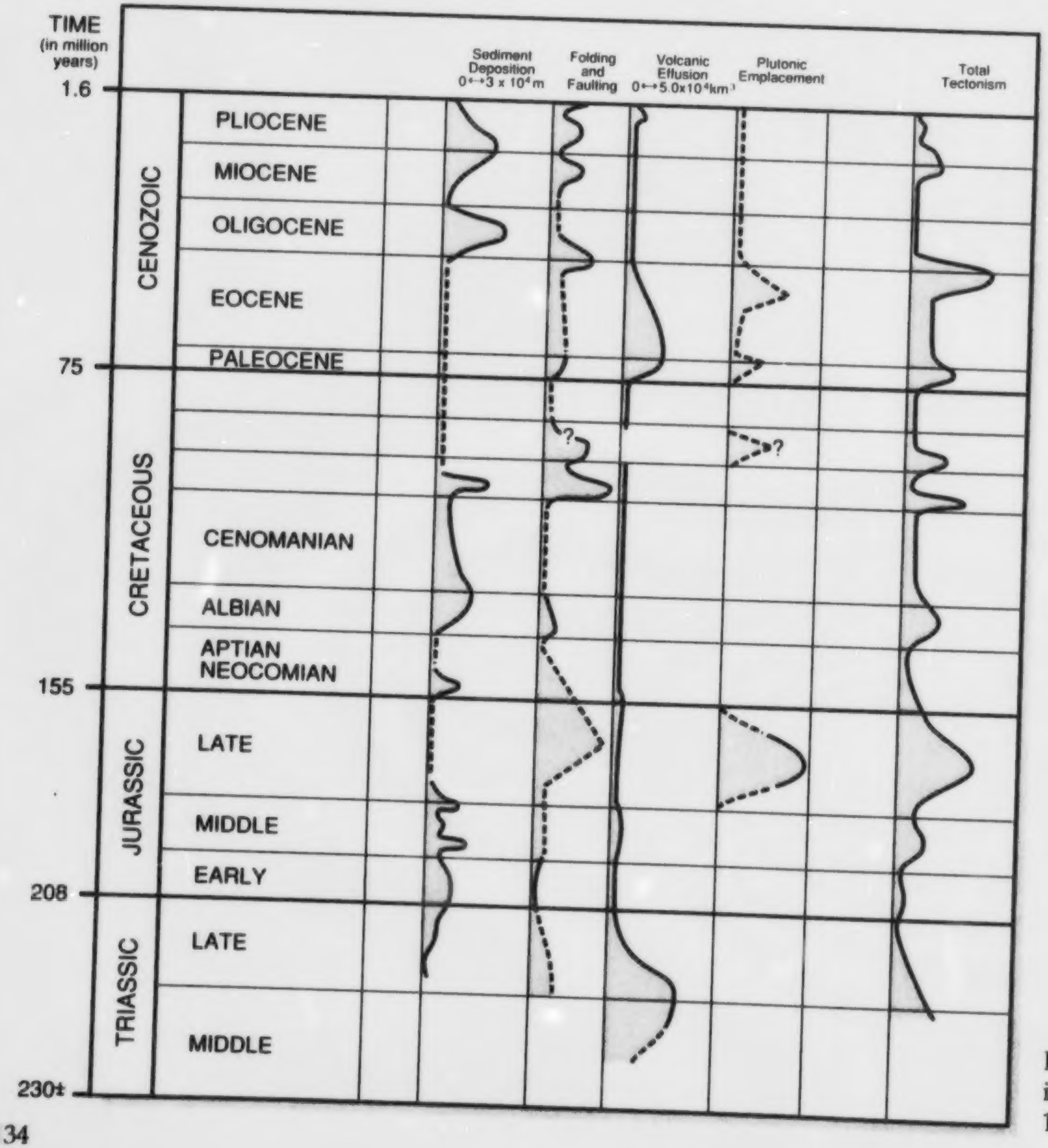

TERRACE ACCRETIONARY SEDIMENTARY WEDGE
OFFSHORE FLEXURAL BULGE
TRENCH
LITHOSPHERE FLEXURE
UP
DOWN
OBLIQUE CONVERGENCE
55 mm/yr
Q.C. ISLANDS
QUEEN CHARLOTTE BASIN
QUEEN CHARLOTTE RIGHT - LATERAL TRANSFORM FAULT
(~50 mm/yr)
FOSSIL FAULTS ?
10 to 20 mm/yr
ORTHOGONAL UNDERTHRUSTING PLATE

Figure 90. Schematic diagram illustrating the flexure of the Continental lithosphere generated by margin underthrusting, The Queen Charlotte Islands are uplifted and Queen Charlotte Basin is sympathetically depressed (after Yorath & Hyndman 1983)

Another, and equally important, part of the geology of the Queen Charlotte Islands is the fact that only the youngest rocks now found on the Islands, originated *in-situ*. Successively older rocks were deposited or accreted by two crustal fragments now referred to as "Alexander" and Wrangellia" terranes, during their slow northward drift from what is believed to be their general point of origin at the latitude of Peru. According to the most recent models, they appear to have collided during their journey, somewhere in the Pacific Ocean, prior to becoming welded to the North American continental margin. They are but two of a number of terranes that were accreted earlier and in a similar manner along this margin (Brown & Yorath 1989).



About 25 million years ago, the geology of the Islands was further affected by rifting of the continental margin which carried them over what is referred to as the "Anahim" hotspot, causing a northward drift and clockwise rotation of the Islands, and the collapse of the deep basin in Queen Charlotte Sound. Embedded in the mantle, this hotspot has been traced eastward under the westward moving continent, based on the string of surface volcanoes left in its wake, from the Masset Plateau, through the Coast Mountain, to the post-glacial Clearwater cones, all located in British Columbia (Brown & Yorath 1989). Brown and Yorath (1989) state that the activity of the Anahim hotspot is in fact analogous to the growth of the Hawaiian volcanoes which underwent a similar time sequence development.

Throughout the history of the movement and rifting that occurred, the Islands have been injected with a wealth of mineral occurrences, while the adjacent Wrangellian rocks of the Queen Charlotte Basin have become the source of at least two hydrocarbon accumulations of apparently commercial value.

Figure 91. Model of the tectonic record affecting the Queen Charlotte Islands (after Anon. 1983a)

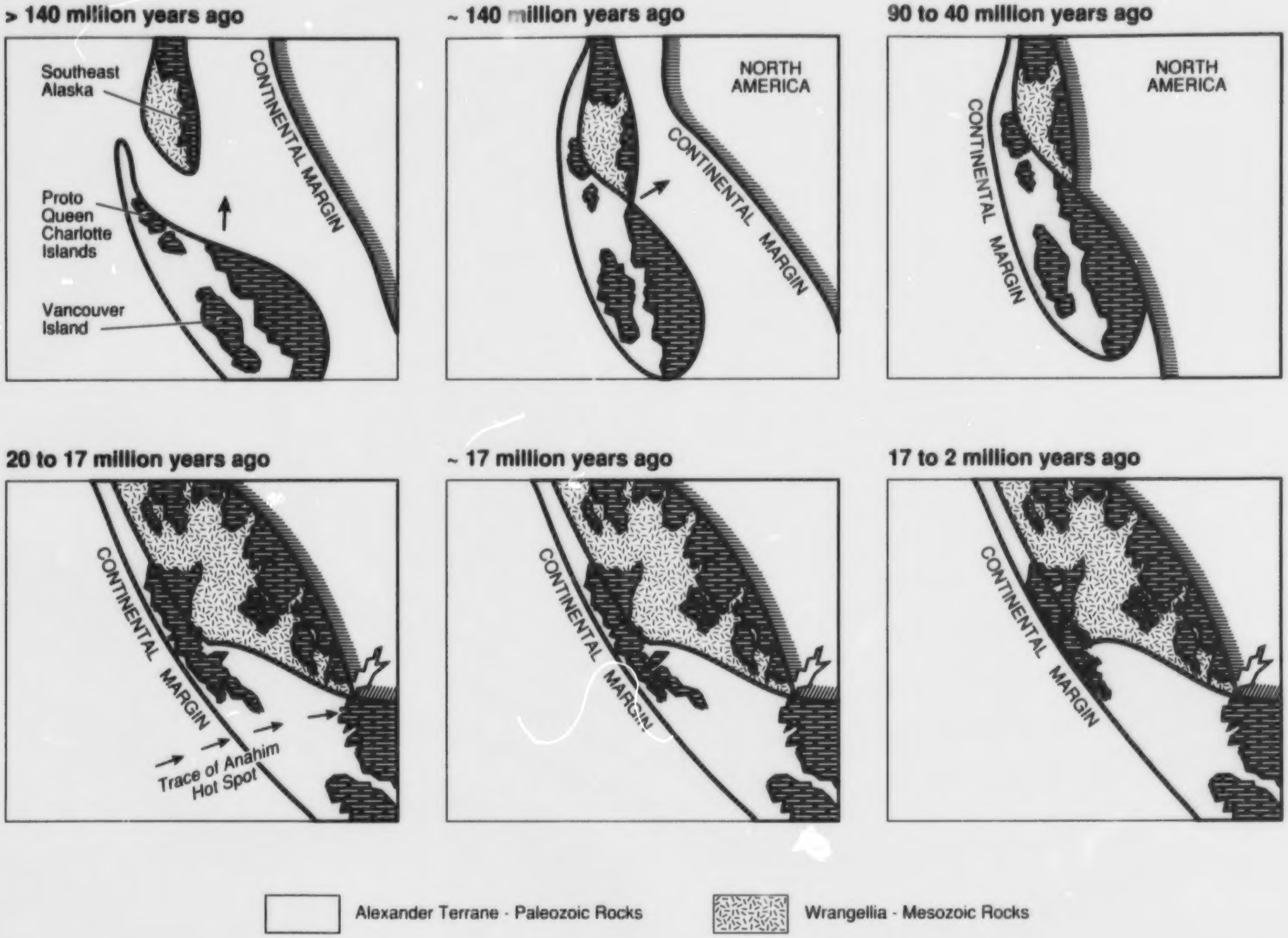

> 140 million years ago
Southeast Alaska
Proto Queen Charlotte Islands
Vancouver Island
CONTINENTAL MARGIN
~ 140 million years ago
NORTH AMERICA
CONTINENTAL MARGIN
90 to 40 million years ago
NORTH AMERICA
CONTINENTAL MARGIN
20 to 17 million years ago
CONTINENTAL MARGIN
Trace of Anahim Hot Spot
~ 17 million years ago
CONTINENTAL MARGIN
17 to 2 million years ago
CONTINENTAL MARGIN
Alexander Terrane - Paleozoic Rocks
Wrangellia - Mesozoic Rocks

Figure 92. Evolution of the Pacific margin with special reference to the Queen Charlotte Islands (after Anon. 1983a)

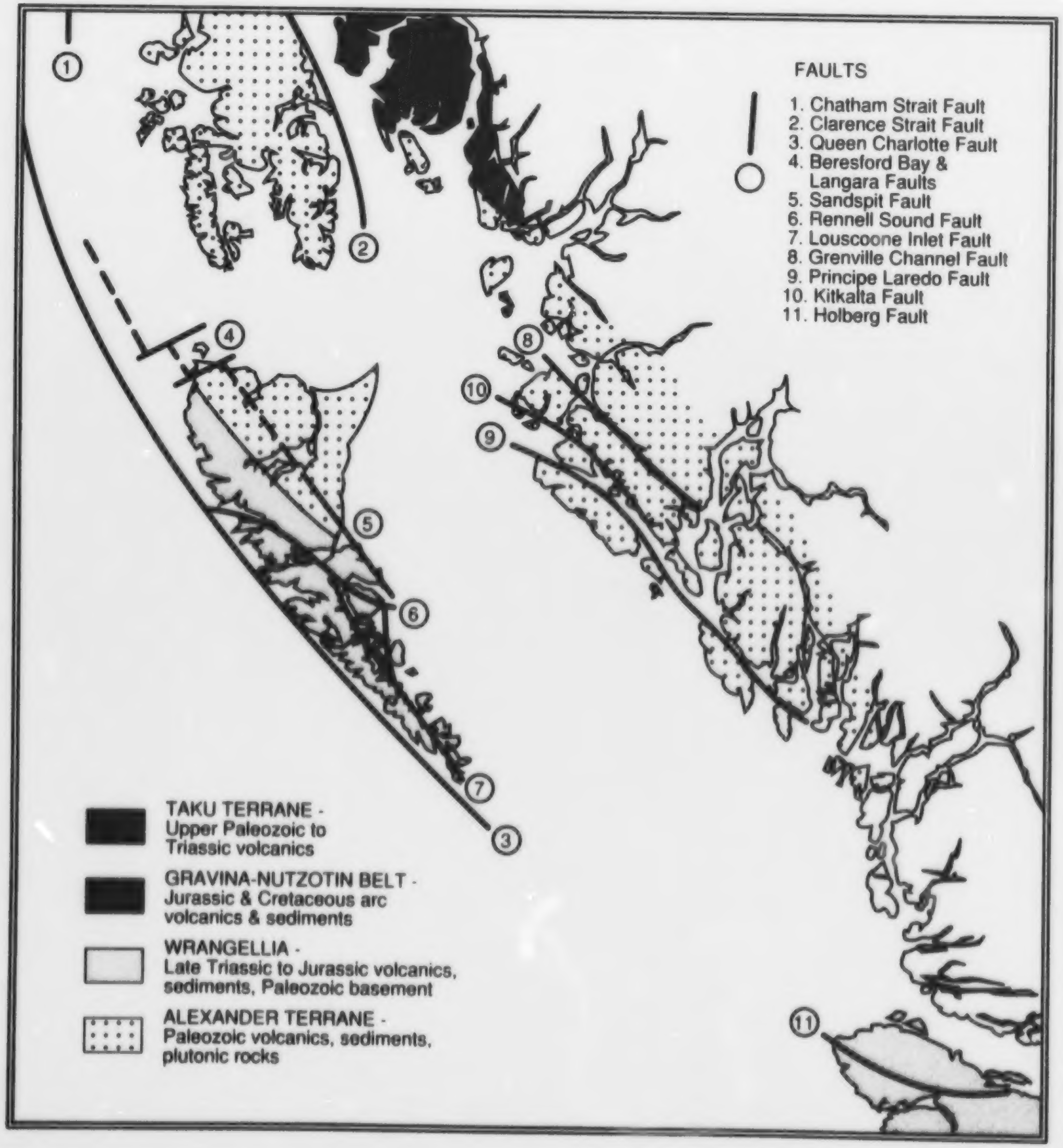

FAULTS
1. Chatham Strait Fault
2. Clarence Strait Fault
3. Queen Charlotte Fault
4. Beresford Bay & Langara Faults
5. Sandspit Fault
6. Rennell Sound Fault
7. Louscoone Inlet Fault
8. Grenville Channel Fault
9. Principe Laredo Fault
10. Kitkalta Fault
11. Holberg Fault
①
②
③
④
⑤
⑥
⑦
⑧
⑩
⑨
⑪
TAKU TERRANE - Upper Paleozoic to Triassic volcanics
GRAVINA-NUTZOTIN BELT - Jurassic & Cretaceous arc volcanics & sediments
WRANGELLIA - Late Triassic to Jurassic volcanics, sediments, Paleozoic basement
ALEXANDER TERRANE - Paleozoic volcanics, sediments, plutonic rocks

Figure 93. Tecto-stratigraphic terranes of the northwest Canadian coast (after Yorath & Chase 1981)

A. TERRESTRIAL GEOLOGICAL RESOURCES

The specific study of the geology of the Islands began over a hundred years ago, when Geological Survey of Canada (G.S.C.) assistant James Richardson, while providing some surveying aid to the Canadian Pacific Railway in 1874, explored the metamorphosed rocks of the coastal region and returned from the Queen Charlotte Islands with a large number of theretofore undescribed fossils. George Mercer Dawson of the G.S.C. visited the Queen Charlotte Islands in 1878 to study the coal deposits there in greater detail than Richardson had. This remarkable scientist not only reported on his geological conclusions, but compiled a comprehensive anthropological report on the customs, language, and life of the Haida Indians. While conducting coal deposit related studies for the G.S.C. in British Columbia with R.A.A. Johnson, R.W. Ellis' main work took him in 1905 to Graham Island to restudy the coal deposits first described by Richardson and further refine the geological ages of the deposits. The same deposits were re-examined by C.H. Clapp in 1913, and by J.D. MacKenzie in 1914, both being members of the G.S.C.

Following these initial geological investigations came a period of intensive explorations by mining interests that covered both Graham- and Moresby Islands, and resulted in a number of active and sometimes large mining ventures. More recently, a large number of researchers has provided a wealth of information on several aspects of the geology and tectonic history of the Islands; *e.g.* Martin & Rouse (1966), Brown (1968), Shouldice (1971), Stacey (1975), Young & Chase (1977), Tipper & Cameron (1980), Shen *et al.* (1981), Yorath & Chase (1981), Clague *et al.* (1982), Yorath & Hyndman (1983), Brown & Yorath (1989), Clague (1986), Dehler & Clowes (1988), and Haggart (1987). The principal geological reference work for the Queen Charlotte Islands, however, remains that of Brown (1968).

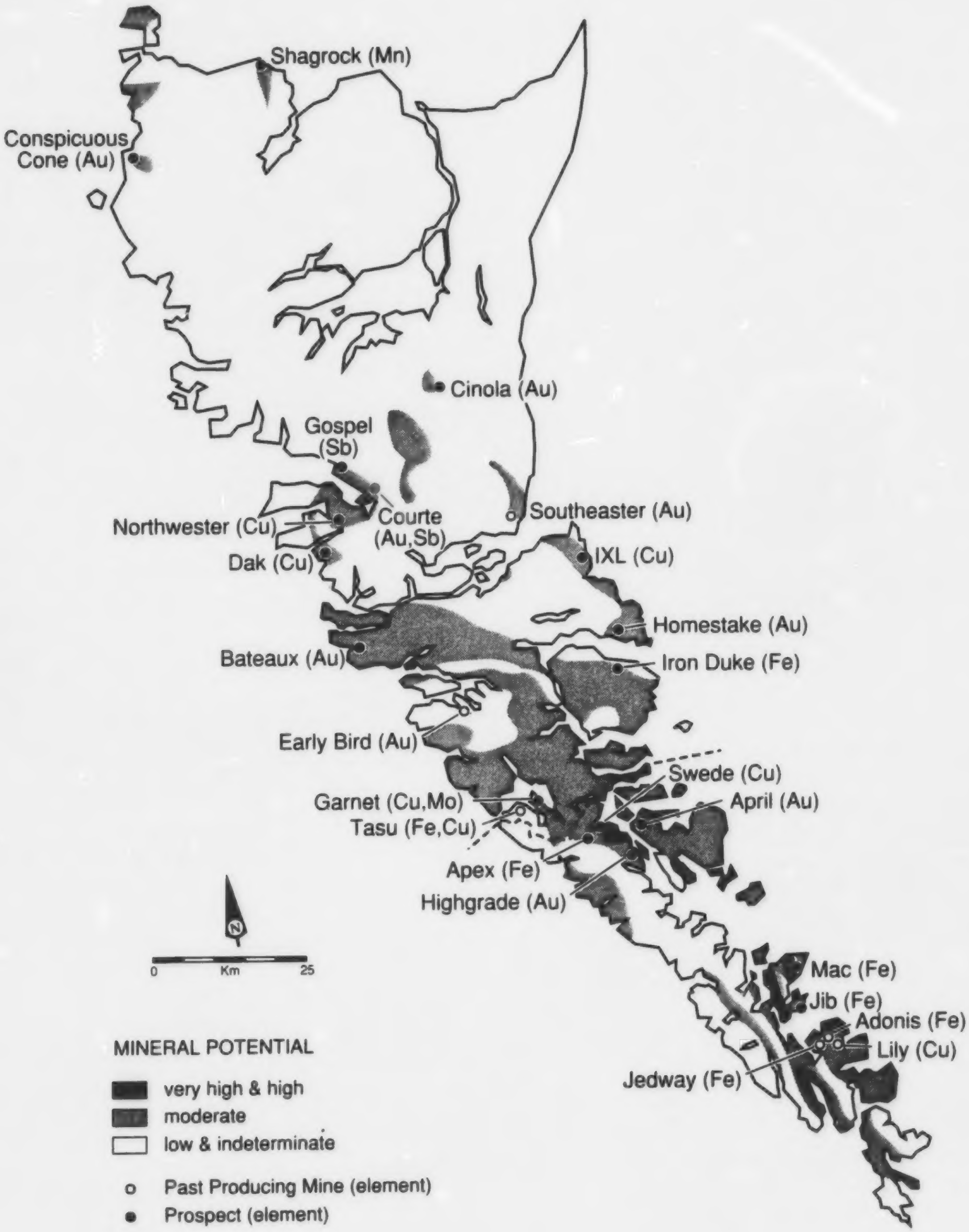

Shagrock (Mn)
Conspicuous Cone (Au)
Cinola (Au)
Gospel (Sb)
Courte (Au,Sb)
Southeaster (Au)
Northwester (Cu)
Dak (Cu)
IXL (Cu)
Homestake (Au)
Bateaux (Au)
Iron Duke (Fe)
Early Bird (Au)
Swede (Cu)
Garnet (Cu,Mo)
April (Au)
Tasu (Fe,Cu)
Apex (Fe)
Highgrade (Au)
N
0
Km
25
Mac (Fe)
Jib (Fe)
Adonis (Fe)
Lily (Cu)
Jedway (Fe)
MINERAL POTENTIAL
very high & high
moderate
low & indeterminate
Past Producing Mine (element)
Prospect (element)

Figure 94. Mineral potential of the Queen Charlotte Islands (after Brown 1986)

The more than fifty islands comprising the Queen Charlotte Islands archipelago are part of the Insular Fold Belt of the Cordilleran Orogen. They are positioned at the western margin of the continent, and are geologically separated from the immediately adjacent floor of the Pacific Ocean by the Queen Charlotte transform fault. This fault is one of the major contacts between the continent and the Pacific Plate along a subduction zone. Along it, the right-lateral translation of the Pacific Plate occurs at a rate of about 55 millimetres annually. The internal stresses and strains of such motion are released as earthquakes, and makes the Islands a part of the seismically most active area of Canada. A shock of 8.1 on the Richter Scale, with an epicentre situated under north-western Graham Island, was recorded in 1949 (Brown & Yorath 1989).

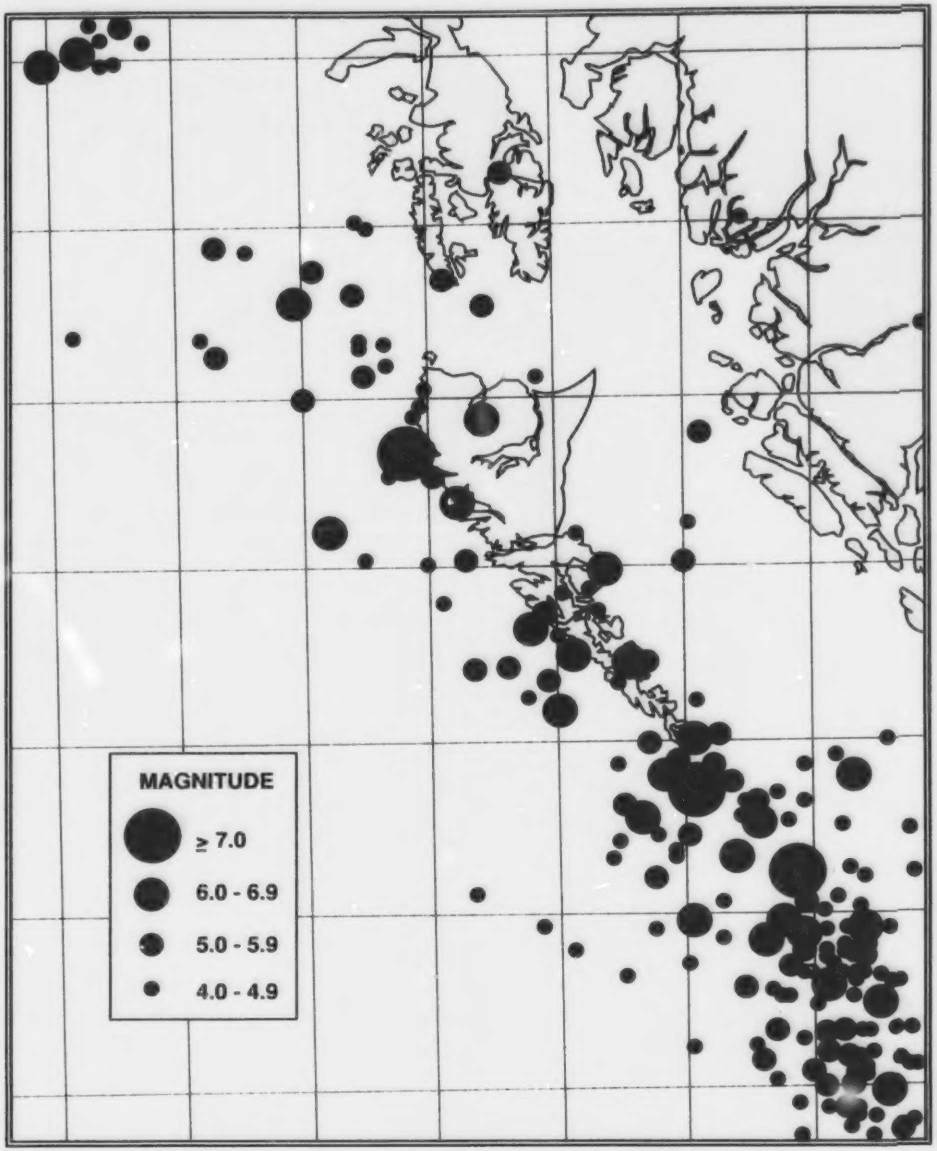


Figure 95. Earthquake epicentres in the area of the Queen Charlotte fault zone, from the Canadian Seismological Service data file. Note that uncertainties in the epicentres are of the order of 25 km and for some of the older events may be as large as 50 km (after Hyndman & Ellis 1981)

The geological structure of the Queen Charlotte Islands is best described by Brown *et al.* 1983:

> **The Islands are constructed from a varied assemblage of Mesozoic and Cenozoic plutonic, volcanic, metamorphic and sedimentary rocks, the components of which are disposed in a northwesterly aligned stratigraphic and structural fabric. Although stratigraphic contacts are common, the dominant form of contact is structural or intrusive, particularly among pre-Mid Cretaceous units. The characteristic structural style of the region is expressed by vertical faults, most of which are aligned sub-parallel to the stratigraphic grain; folds are commonly of low amplitude except close to major shears where steep upright to overturned panels occur.**

The Insular Fold Belt consists of rocks of Late Paleozoic to Tertiary age, and is characterized by thick, and only slightly deformed sequences of volcanic rocks of Mesozoic age. Three major faults within the Queen Charlotte Islands are known to dislocate the stratigraphic continuity, they are the *Rennell Sound Fault Zone*, the *Louscoone Inlet Fault Zone*, and the *Sandspit Fault System* (Brown *et al.* 1983).

- The *Rennell Sound Fault Zone* consists of a set of broadly curvilinear and northwesterly trending, vertical to steeply southeasterly dipping shears. This zone extends from Rennell Sound to Louise Island and finds its strongest expression in the weaker sediments of the Mid- to Upper Cretaceous Queen Charlotte Group.

- The *Louscoone Inlet Fault Zone* consists of major strands of vertical shears with apparent right lateral separation. This zone extends northwesterly from southernmost Kunghit Island through the island passages of Eastern Moresby Island to Louise Island, where it appears to be truncated by the Rennell Sound Fault Zone.

- The *Sandspit Fault System* has a somewhat less clear history. Yorath and Chase (1981) suggest that this fault system was once continuous and colinear with the Louscoone Inlet Fault Zone, but became later dislocated by the movement of the Rennell Sound Fault Zone. Yorath and Hyndman (1983) suggest that this dislocation might have been associated with crustal rifting in Queen Charlotte Sound during the Early Miocene. This fault system's movements have been noticeable in recent times.

More specifically, Brown (1968) described the structural units of the Queen Charlotte Islands as follows:

> **The fundamental structural unit of the Queen Charlotte Islands is a thick (15,000+ feet) pillowed basalt of Late Triassic age. The basalts are separated by a flysh-like sequence of Latest Triassic and Early Jurassic age from an explosive porphyritic andesite of Middle Jurassic age and largely marine deposition. Two Cretaceous sedimentary units, the first flysh-like and the second molasse-like, were deposited and are successively less involved in deformation. A final Early Tertiary period, largely of subaerial volcanism, deposited some 18,000 feet of intercalated alkali basalt floods and sodic rhyolite ash flows. These are gently warped, eroded, and overlain by up to 6,000 feet of Mio-Pliocene sands and shales. Large lineal bodies of hornblende diorite to quartz diorite were emplaced in the Mid to Late Jurassic and a more varied sequence of quartz diorite to sodic granite in then Early Tertiary, mostly along major lineal faults.**

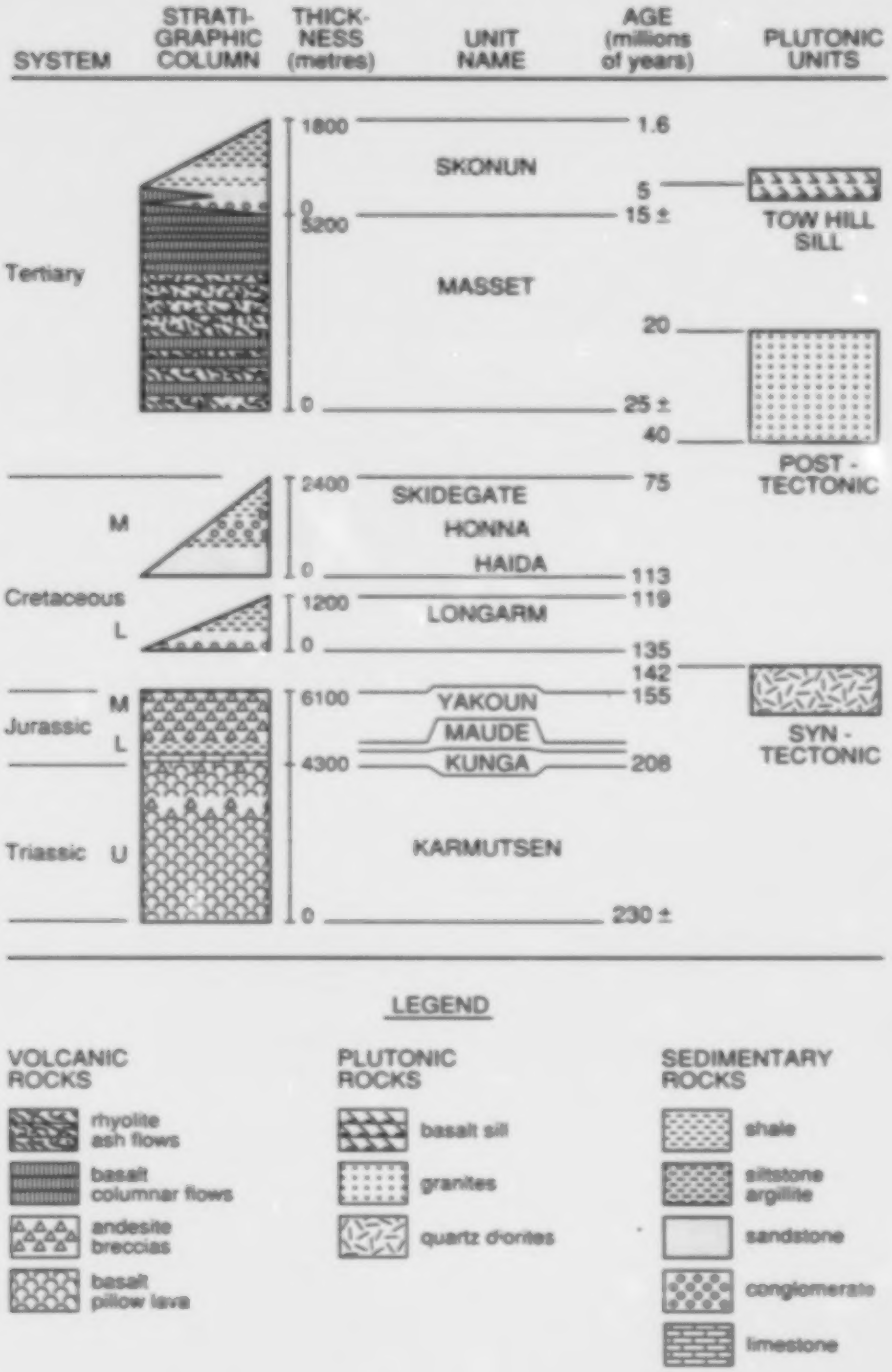

SYSTEM
STRATI-GRAPHIC COLUMN
THICK-NESS (metres)
UNIT NAME
AGE (millions of years)
PLUTONIC UNITS
1800
1.6
SKONUN
5
0
15 ±
5200
TOW HILL SILL
Tertiary
MASSET
20
0
25 ±
40
POST - TECTONIC
2400
SKIDEGATE
75
M
HONNA
0
HAIDA
113
Cretaceous
1200
LONGARM
119
L
0
135
142
M
6100
YAKOUN
155
Jurassic
MAUDE
L
4300
KUNGA
208
SYN - TECTONIC
Triassic
U
KARMUTSEN
0
230 ±
LEGEND
VOLCANIC ROCKS
rhyolite ash flows
basalt columnar flows
andesite breccias
basalt pillow lava
PLUTONIC ROCKS
basalt sill
granites
quartz diorites
SEDIMENTARY ROCKS
shale
siltstone argillite
sandstone
conglomerate
limestone

Figure 96. Stratigraphic column for the Queen Charlotte Islands, indicating four deposition phases and Volcanic, Plutonic and Sedimentary rock units (after Brown & Yorath 1989)

The oldest stratigraphic rock unit found on the Islands is known as the **Karmutsen Formation** and is believed to be of Upper Triassic age. It consists of about 4,300 metres of thickly piled pillow basalts, breccias, aquagene tuffs, massive basalt flows and sills, with minor components of interlava limestones and some volcanic sandstones. The formation has yielded some undiagnostic crinoid columns conceivably of Permian age. This formation is the basal component of the quadruple Vancouver Group which define the tectono-stratigraphic terrane of "Wrangellia" (Brown *et al.* 1983).

The **Kunga Formation** of Late Triassic and Early Jurassic age overlies the Karmutsen Formation conformably, and attains a thickness of about 1,050 metres. Its three members consist of recrystallized limestone, black limestone, and black argillite. The formation is widely exposed, but rarely in large outcrops. The upper member contains Arietitid ammonites including *Arniotites* sp. The middle member contains abundant *Halobia* sp. and *Monotis* sp. coquinas (Brown *et al.* 1983).

Widely scattered and small outcrops of the **Maude Formation** of Early Jurassic Age overly the Kunga Formation conformably. About 200 metres in thickness, this unit consists of argillite, shale, and sandstone rich in benthonic and pelagic faunas (Brown *et al.* 1983).

The **Yakoun Formation** of Middle to early Late Jurassic age, the youngest member of the Vancouver Group, overlies the Maude Formation conformably with its 1000 to 2000 metre thickness. It represents the uppermost component of "Wrangellia", and consists mainly of volcanic material dominated by pyroclastic rocks, but includes volcanic sandstone, conglomerate, fossiliferous shale, siltstone and minor amounts of coal. Volcanic flows are rare, while dikes are common (Brown *et al.* 1983).

The approximately 1,200 metres of the two facies of the Lower Cretaceous **Longarm Formation**, overly the Yakoun Formation conformably and unconformably. Turbidite sequences, large clasts of the Upper Jurassic plutons, greywackes and argillites with abundant *Inoceramus* clasts are present. This formation along with the Upper Jurassic syntectonic plutons, has been included in the "Suture Assemblage" of Yorath and Chase (1981) who believe the mega-conglomerates to be erosional remnants of high relief structures resulting from the collision of the "Wrangellia" and "Alexander" terranes (Brown *et al. 1983.).*

This formation is also known for the only hot springs in the Queen Charlotte Islands. Situated in the southwest corner of Hot Springs Islands, about 15 springs and seepages occur on the surface, while other subterranian conduits have given rise to a very unique geothermal meadow. It has been suggested that the hydrothermal activities may be associated with the nearby Rennel - Louscoone Fault complex (McDonald *et al.* 1978).

The Longarm Formation is overlain unconformably by the 3,000 metre thick Queen Charlotte Group of Mid to Upper Cretaceous age. The group is considered to be a "Post-Suture Assemblage" by Yorath and Chase (1981) and consists of three components; *i.e.*:

- the lowermost **Haida Formation** ; 820 metres of sandstone, overlain by 330 metres of shale; richly fossiliferous;
- the **Honna Formation** ; 400-1,200 metres of conglomerates and coarse sandstones overlying the Haida Formation; fossils are rare (Early Campanian ammonites);
- the **Skidegate Formation** ; 600 metres of interbedded sandstone, siltstone, mudstone and shale overlying the former formation; few undiagnostic pelecypods (Brown *et al.* 1983).

- All of the foregoing groups and formations are believed to be syntectonic plutonic units.

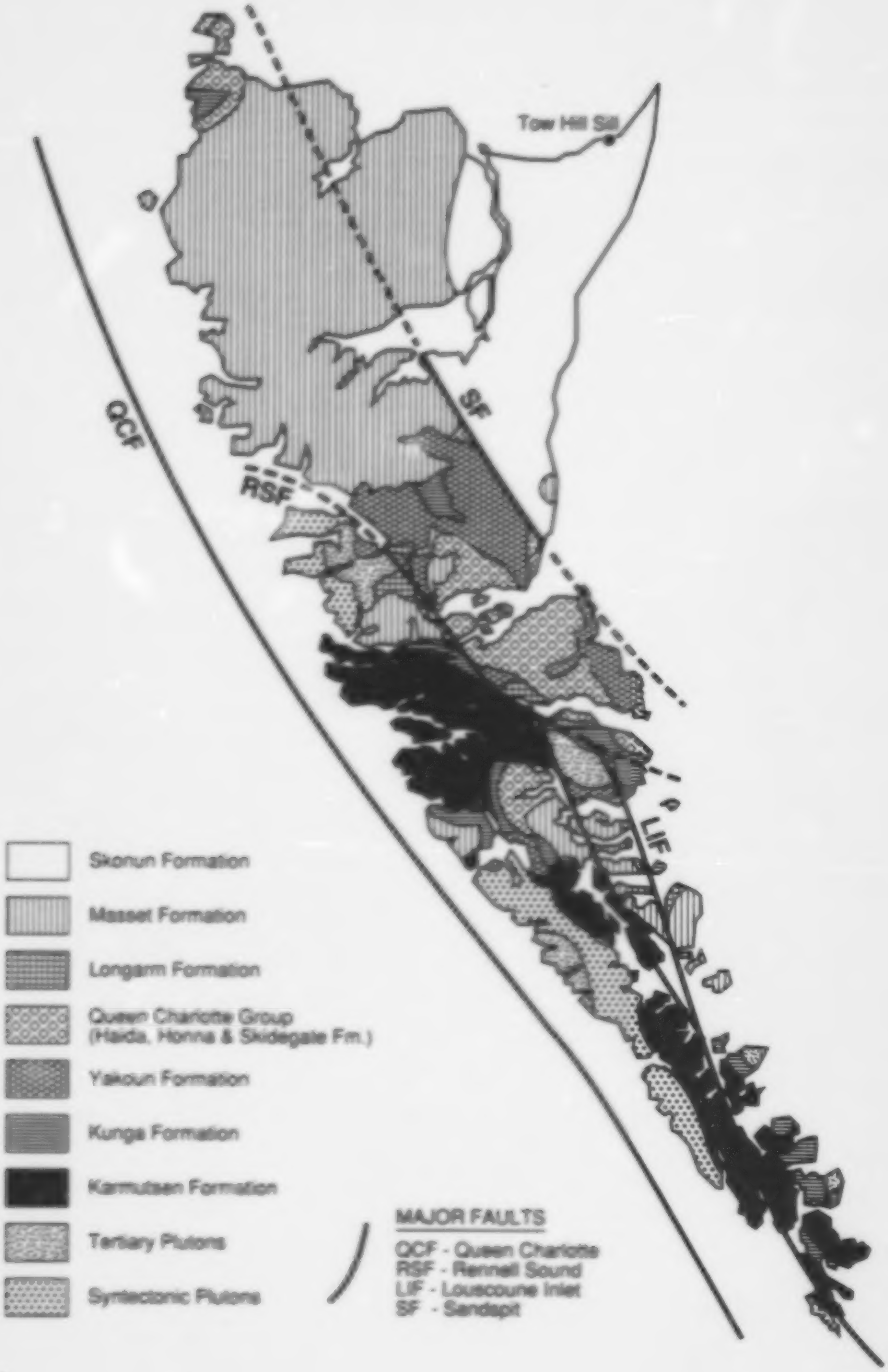

Tow Hill Sill
SF
QCF
RSF
LIF
Skonun Formation
Masset Formation
Longarm Formation
Queen Charlotte Group (Haida, Honna & Skidegate Fm.)
Yakoun Formation
Kunga Formation
Karmutsen Formation
Tertiary Plutons
Syntectonic Plutons
MAJOR FAULTS
QCF - Queen Charlotte
RSF - Rennell Sound
LIF - Louscoune Inlet
SF - Sandspit

Figure 97. Generalized geolocical map of the Queen Charlotte Islands (after Brown & Yorath 1989)

The **Masset Formation** overlies the Queen Charlotte Group and is believed to be the first post-tectonic formation. It is a 1,200 to 5,500 metres thick sequence of rhyolite and basalt flows, and pyroclastic rocks. Welded rhyolite ash flows and columnar basalts occur on Graham Island, while an admixture of volcanic clasts is common on eastern Moresby Islands. A series of nothwesterly aligned, small plutons ranging from quartz diorite to sodic granite, are closely associated with this formation. Yorath and Chase (1981) considered the Masset Formation to be the lowermost component of the "Rift Assemblage" as a result of the westward drift of the North American Plate over the Anahim hot spot.

The **Skonun Formation** of Miocene and Pliocene age is the uppermost component of the Rift Assemblage just described. It consists of 1,800 metres or more of marine and non-marine sandstones, shaly mudstones, minor conglomerate and lignite. The formation is intruded by the Tow Hill sill of olivine basalt on north-eastern Graham Island.

While the underlying character of the present landscapes is primarily the product of plate movements and tectonic uplift, the visual expression of their present surficial geology is the result of glacial and fluvial erosion and deposition. Throughout the Quaternary Period, the Islands are said to have experienced repeated climatic fluctuations resulting in alternating glacial and interglacial conditions. Evidence obtained from marine sediments points to the occurrence of about twelve major glacial episodes during the past 2 million years (Anon. 1988d). The terrestrial evidence of those episodes has been largely erased by succeeding episodes, so that only the latter stages (primarily Fraser) of the last glacial advance (Wisconsinan) can be identified with some certainty (Clague 1981).

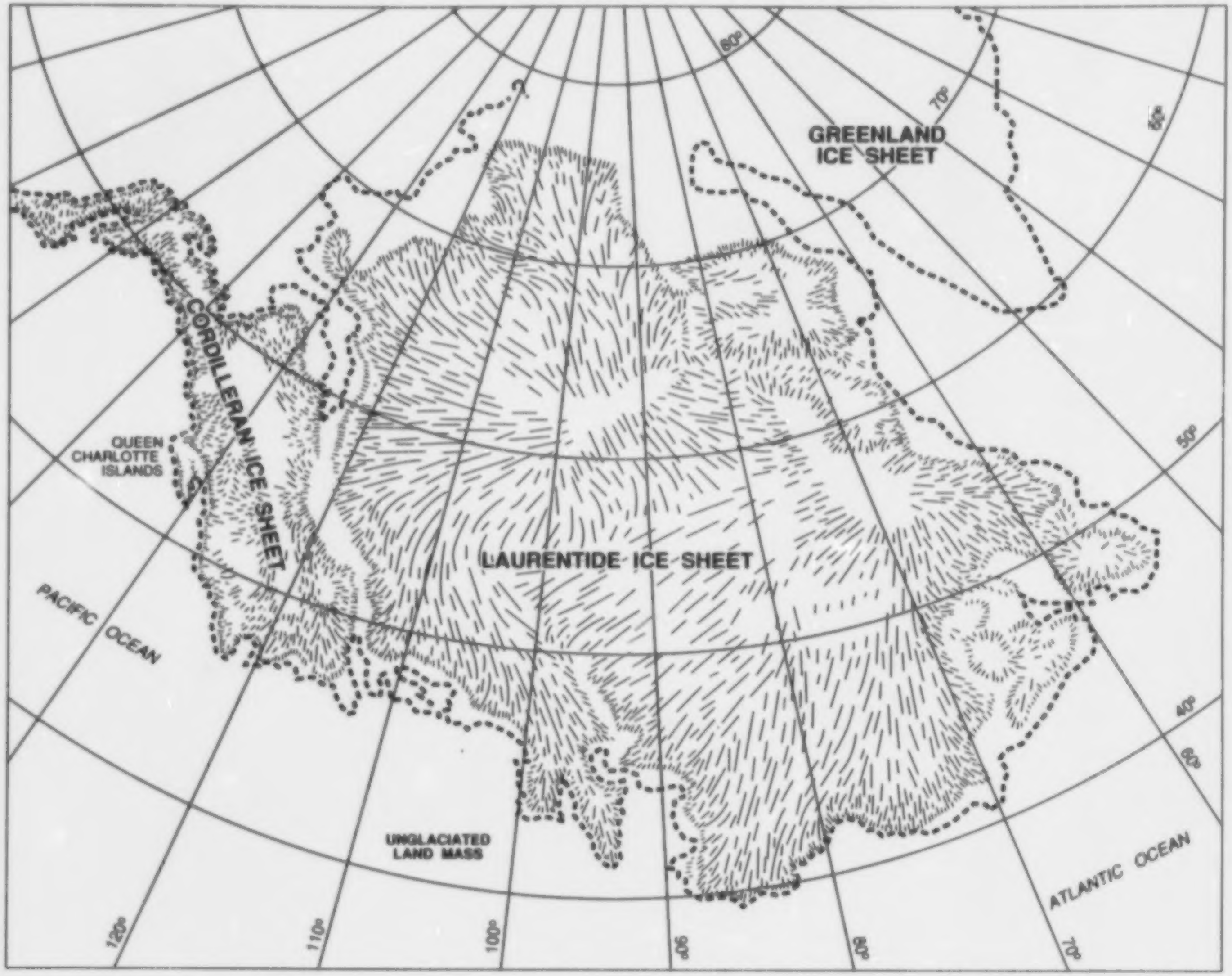

80°
70°
GREENLAND ICE SHEET
60°
CORDILLERAN ICE SHEET
QUEEN CHARLOTTE ISLANDS
50°
LAURENTIDE ICE SHEET
PACIFIC OCEAN
40°
60°
UNGLACIATED LAND MASS
ATLANTIC OCEAN
120°
110°
100°
90°
80°
70°

Figure 98. Extent of North American ice sheets during the last glaciation. Dashed lines indicate maximum proposed reconstruction along the northern, eastern and southern boundaries (after Booth 1987)

Clague (1989) believes that during each major Pleistocene glaciation, the Islands supported mainly mountain ice caps and a network of valley and piedmont glaciers, all of which developed independent of the Cordilleran ice sheet on the mainland. However, at least once did a lobe of that ice sheet extend across the Hecate Strait to coalesce with local glaciers occupying eastern Graham Island. Brown's (1968) work laid the base for more recent analyses of the ice movement on and across the Islands, when he used the alignments of striae with roches moutonees, rock drumlins, and flutings, to show that glacial ice moved generally outward from an ice divide along the height of land. He surmised that any ice flowing in a westerly direction from the divide might have formed a small ice shelf, while eastward flowing ice probably came in contact with the ice that had flowed across Hecate Strait from the Cordilleran ice sheet on the mainland.

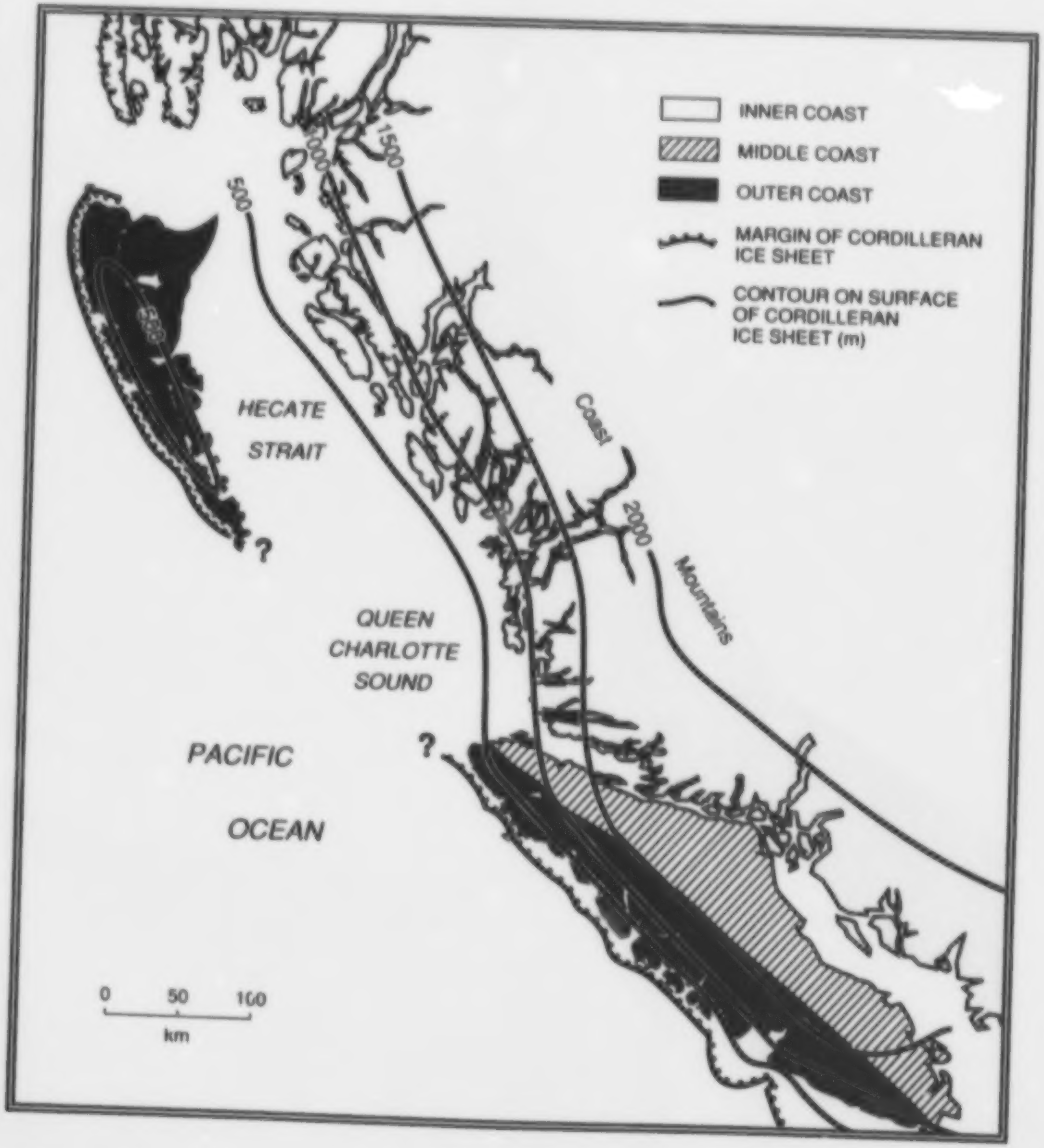

INNER COAST
MIDDLE COAST
OUTER COAST
MARGIN OF CORDILLERAN ICE SHEET
CONTOUR ON SURFACE OF CORDILLERAN ICE SHEET (m)
500
1000
1500
2000
Coast
Mountains
HECATE STRAIT
QUEEN CHARLOTTE SOUND
PACIFIC OCEAN
?
?
0
50
100
km

Figure 99. Margins and contour surfaces of the Cordilleran icesheet for the late Wisconsin glacial maximum (ca. 14,500 - 15,000 years ago) which are speculative (after Clague et al. 1982)

Warner *et al.* (1982) provided radiocarbon dates and plant macrofossils which established that portions of Graham Island near Cape Ball were ice-free "during and subsequent to" the Late Wisconsinan glacial maximum along the northwestern segment of the Pacific Ocean coast; *i.e.* ~ 16,000 years ago. That date alone raises a sufficient number of questions to revitalize the argument that a biotic refugium might have been present on the Queen Charlotte Islands during the last glaciation.

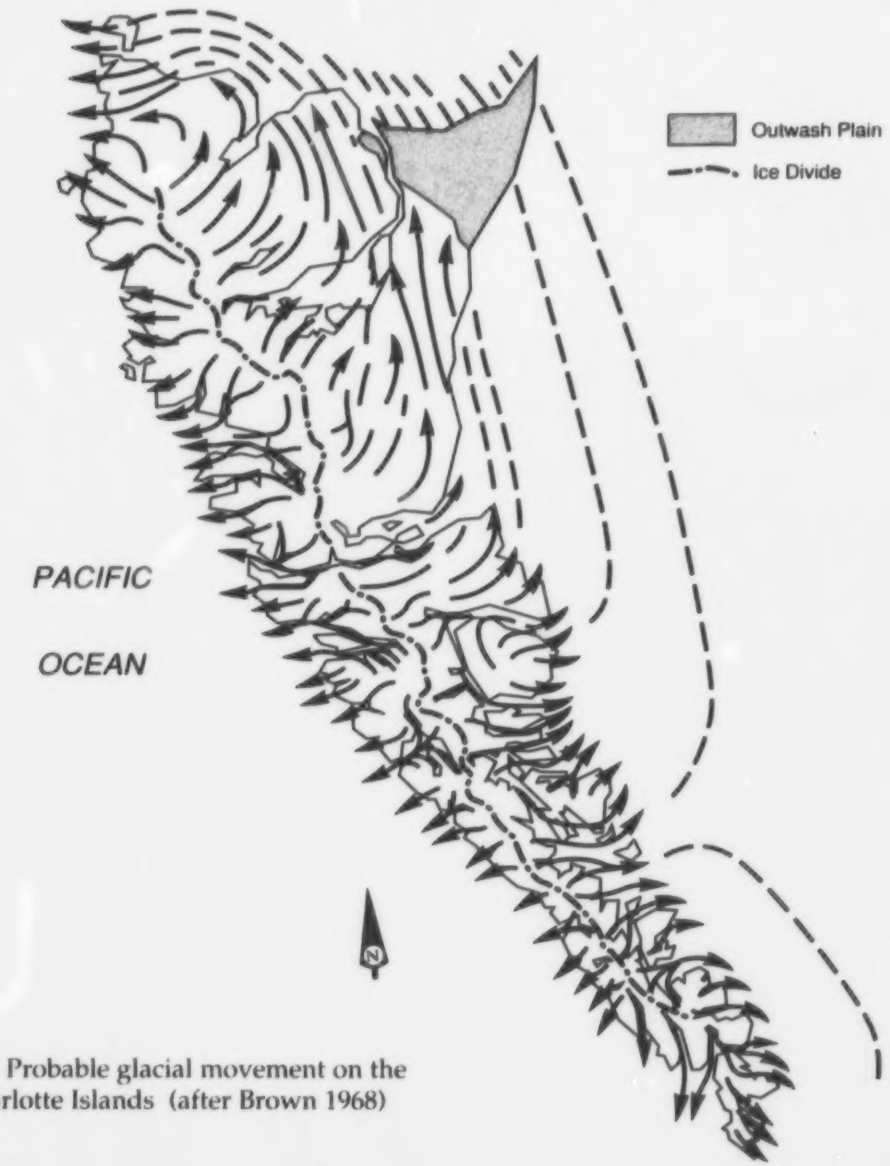


Figure 100. Probable glacial movement on the Queen Charlotte Islands (after Brown 1968)

During the Late Quaternary and Early Holocene, the retreat and downwasting of the last Wisconsinan glaciers brought about complex pattern of sea level changes, attributed to the corresponding isostatic responses of local portions of the earth's crust. It is of course acknowledged that diastrophic and eustatic crustal activities and responses more than likely were periodically responsible for some of the sea level fluctuations. Clague *et al.* (1982) established that sea levels along the outer coast were below present levels approximately 9,160 to 12,400 years ago. The evidence presented (Clague *et al.* 1982), includes drowned river mouths at Cape Ball and Oeanda Rivers, submerged stream channels and associated wave-cut scarps 33 metres below the present sea level in Hecate Strait, and Late Pleistocene or Early Holocene archaeological sites situated in the modern intertidal zone on Moresby Island. A period of oceanic transgression followed about 9,500 to 10,000 years ago which brought sealevel higher than its present position. Lowland areas on Graham-, Moresby-, and other islands inundated. While the highest elevation reached by the transgression has not yet been firmly established, wave-cut scarps and beach deposits have been noted at an elevation 15 metres above the present sea level on eastern Graham Island. The transgression climaxed about 7,500 to 8,000 years ago, then receded slowly relative to the surface of the land until about 5,000 to 6,000 years ago, and rapidly after that to the present level.

As a result of glacial action and postglacial fluvial erosion and deposition certain well-developed and prominant landscape features can now be noted (Clague 1989):

Glacial Landforms and Features -
fjords, U-shaped valleys, hanging valleys, cirque basins, tarns, horns, striae, polished surfaces, roches.

Postglacial Fluvial Landforms and Features -
outwash plains, floodplains, fluvial terraces, alluvial fans, deltas, cones, elevated wave-cut scarps.

Somewhat related to glacial and early postglacial glacio-fluvial phenomena on Graham- and Moresby Islands, is the development of noteworthy karst features. McKenzie (1984) reported on the presence of sinkholes and caves within the limestones of the **Kunga Formation.** The caves appear to be better developed on Moresby Island, particularly within the vicinity of Deena Creek. Of the several caves now known, the Beauty Cave and Kunga Cave have been formally explored and reported upon by members of the Alberta Speleological Society. The former cave is known to exhibit stalagmites, stalagtites, straws, moonmilk and flowstone, among other features. It is important to note that the widely disbursed presence of the Kunga Formation and the general inaccessibility of much of Moresby Island, and in particular the park reserve, make it highly unlikely that the full extent of karst occurrences can be known at this time.

a) RESOURCE ANALYSIS

The geological history of the Queen Charlotte Islands, and therefore the South Moresby/Gwaii Haanas National Park Reserve, is outstanding and in several aspects unique, when compared with that of the other parks and park reserves currently comprising the Canadian national park system. Nowhere else within the system, is the geology of an area known to have been as historically intriguing, scientifically complex, tectonically active, and now as well documented as it is in this case. Granted, some of the conclusions drawn so far by the researchers remain to be hypothetical, but the underlying scientific concepts are sufficiently far advanced, so as to suggest that further fine-tuning might turn out to be the rule rather than their replacement.

More recently, normal academic and scientific interest in the geology of the area, has been given new impetus with the emergence of a strong economic interests by several oil exploration and extraction companies, in the hydrocarbon potential of the Islands and surrounding ocean basins. Their combined research and subsequent environmental assessments have contributed considerably to the current level of understanding of the geological processes, and the distribution of that information. Without their research initiatives the extent and depth of the current data base would not be available.

Collectively, the amount and complexity of the geological information now readily available, is so large, and requires such amounts of analytical and integrative work, that a full analysis of its effect on and implications for park management purposes must wait till another day to do it justice. For instance, the presence of several geological and geotechnical hazards is well documented; i.e., earthquakes, tsunamis, hot springs, slope and sediment instability, sediment erosion, transport and deposition, among others; but their site-specific effects on the physical environment, park operations, public safety, etc., must yet be studied and analyzed in greater detail to be better and more fully understood.

Management Concerns

As already alluded to, before effective decisions can be made about the management of the full range of terrestrial geological resources found within South Moresby/Gwaii Haanas National Park Reserve, three benchmarks must be reached:

- *the area of the park reserve must first be designated as a formal "national park" under the auspices of the National Parks Act and its Regulations;*

- *the politico-economic situation pertaining to the mineral claims and explorations presently in good standing must be fully clarified and resolved in the light of the National Parks Act and its Regulations; and . . .*

- *the Canadian Parks Service must initiate a number of workshops or studies in order to more fully understand the nature and extent of the various geological and geotechnical hazards on the natural resources themselves, on park management practices and facilities, as well as on public safety.*

Other, but closely related management concerns pertain (a) to the geology, management and public use of Hot Springs Island and the nearby, unique geohydrothermal meadow, (b) the protection and preservation of significant fossil outcrops, (c) the discovery and exploration of mega-karst features, including caves, (d) the protection and preservation of mineral outcrops, and the closing-out and rehabilitation of old mining activities, structures and appurtenances, and finally (e) the exploration, mapping and interpretation of the full range of significant landscape features exhibited on South Moresby Island.

Status of Knowledge

The general status of knowledge about the various facets of geology and geological history about the Queen Charlotte Islands archipelago is excellent, even though most of the information was collected in a thematic manner, is largely esoteric in context, and seldom integrated with related research or other sciences. The knowledge thus assembled ought to serve the various park- and resource managers well, in terms of gaining a practical level of broad understanding about the geology of the archipelago and surrounding region.

The knowledge base for the more site-specific geological, geomorphological, and geotechnical information for Moresby Island and the park reserve specifically, is poor to non-existent. Certainly more studies need to be conducted before even an adequate working level of basic geological, etc., knowledge becomes available.

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B. MARINE GEOLOGICAL RESOURCES

In terms of their tectonic history, the terrestrial and marine components of the South Moresby/Gwaii Haanas National Park Reserve are inseparable. The land-water interface is not the boundary to geologic resources that it is to many others. Nor is it possible to consider the geologic history of the area of the park reserve in exclusion from that of the region. Like the climate, the geology of the area is very much a diffuse natural element.

The Pacific Ocean basin becomes progressively younger as it approaches the coastline of British Columbia (Springer 1982). Upper Cretaceous and Lower Jurassic elements of the central Pacific give way gradually to Miocene and younger structures immediately seaward of the Pacific Continental shelf and slope. While the geology of the Pacific Continental shelf and slope itself is poorly known, seismic refraction surveys have revealed that Tertiary sedimentary rocks cover an igneous basement (Johnson *et al*. 1972).

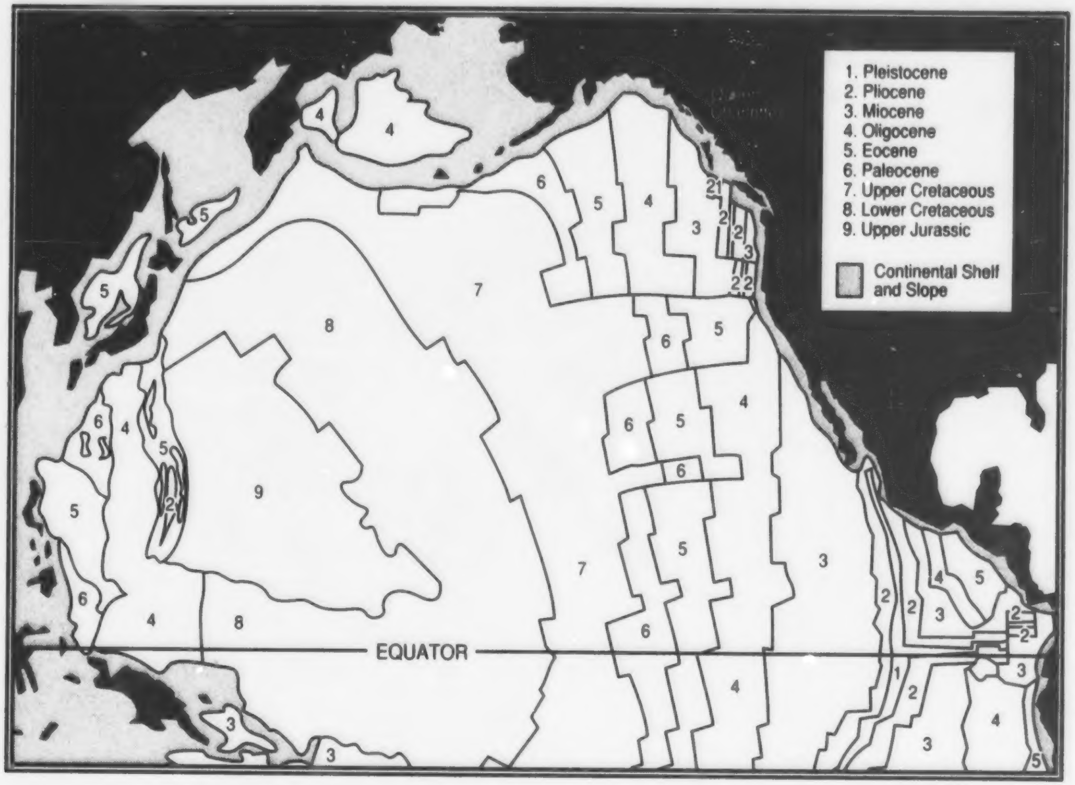

1. Pleistocene
2. Pliocene
3. Miocene
4. Oligocene
5. Eocene
6. Paleocene
7. Upper Cretaceous
8. Lower Cretaceous
9. Upper Jurassic
▨ Continental Shelf and Slope
EQUATOR

Figure 101. Age of the northern Pacific Ocean basin (after Springer 1982)

Beneath the Continental rise and slope of the Dixon Entrance area lie thick sequences of Tertiary and Cretaceous sedimentary rocks (Anon. 1983a). The same Skonun Formation which forms the Queen Charlotte Lowland (see Terrestrial Geological Resources) extends throughout most of Hecate Strait and the Queen Charlotte Sound.

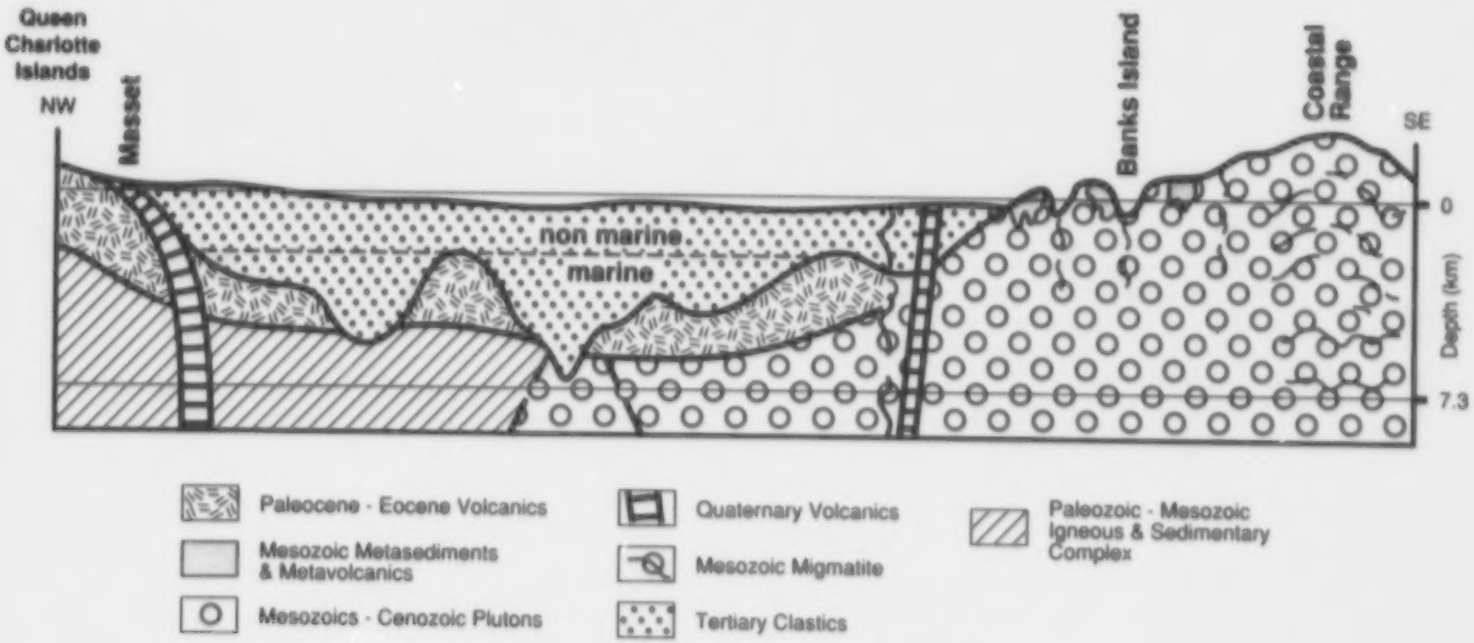

Queen Charlotte Islands
NW
Masset
non marine
marine
Banks Island
Coastal Range
SE
0
Depth (km)
7.3
Paleocene - Eocene Volcanics
Mesozoic Metasediments & Metavolcanics
Mesozoics - Cenozoic Plutons
Quaternary Volcanics
Mesozoic Migmatite
Tertiary Clastics
Paleozoic - Mesozoic Igneous & Sedimentary Complex

Figure 102. Schematic cross-section of Dixon Entrance and Hecate Strait showing major structural components (after Shor 1962, Shouldice 1973)

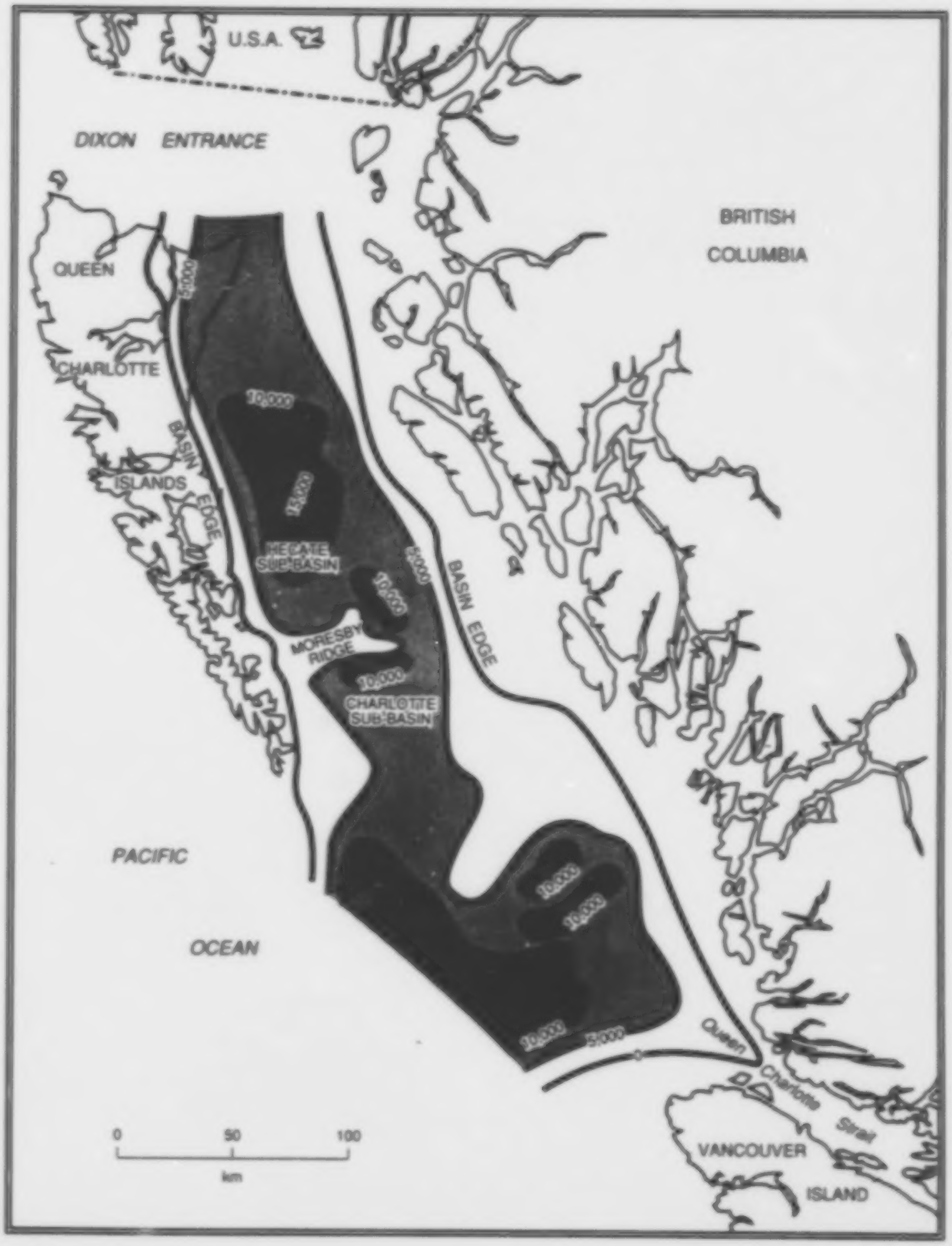

U.S.A.
DIXON ENTRANCE
BRITISH COLUMBIA
QUEEN CHARLOTTE ISLANDS
BASIN EDGE
5,000
10,000
15,000
HECATE SUB-BASIN
10,000
5,000
BASIN EDGE
MORESBY RIDGE
10,000
CHARLOTTE SUB-BASIN
PACIFIC OCEAN
10,000
10,000
10,000
5,000
0
Queen Charlotte Strait
VANCOUVER ISLAND
0
50
100
km

Figure 103. Thickness of the Skonun Formation in Hecate Strait and Queen Charlotte Sound (after Shouldice 1973, Young 1981)

The tectonic history of the area, as described in detail under Terrestrial Geological Resources, is such that there may have been sufficient thermal metamorphism to produce two sources of oil in the Tertiary sediments of Hecate Strait and Queen Charlotte Sound (Anon. 1983a). One such possible source are the Upper Triassic and Jurassic rocks of Wrangellia. While these rocks do contain significant amounts of oil on the Queen Charlotte Islands, offshore they may be so deeply buried under Tertiary sediment as to be too deep for present drilling techniques. There is the possibility, though, that they have served as source rocks for oil migrating and accumulating in the Tertiary strata above. A second potential source of oil is the Tertiary sediment itself. There are a number of other possibilities as well, one of the most attractive of which is that a thick delta of Cretaceous age in the western part of Dixon Entrance may bear oil.

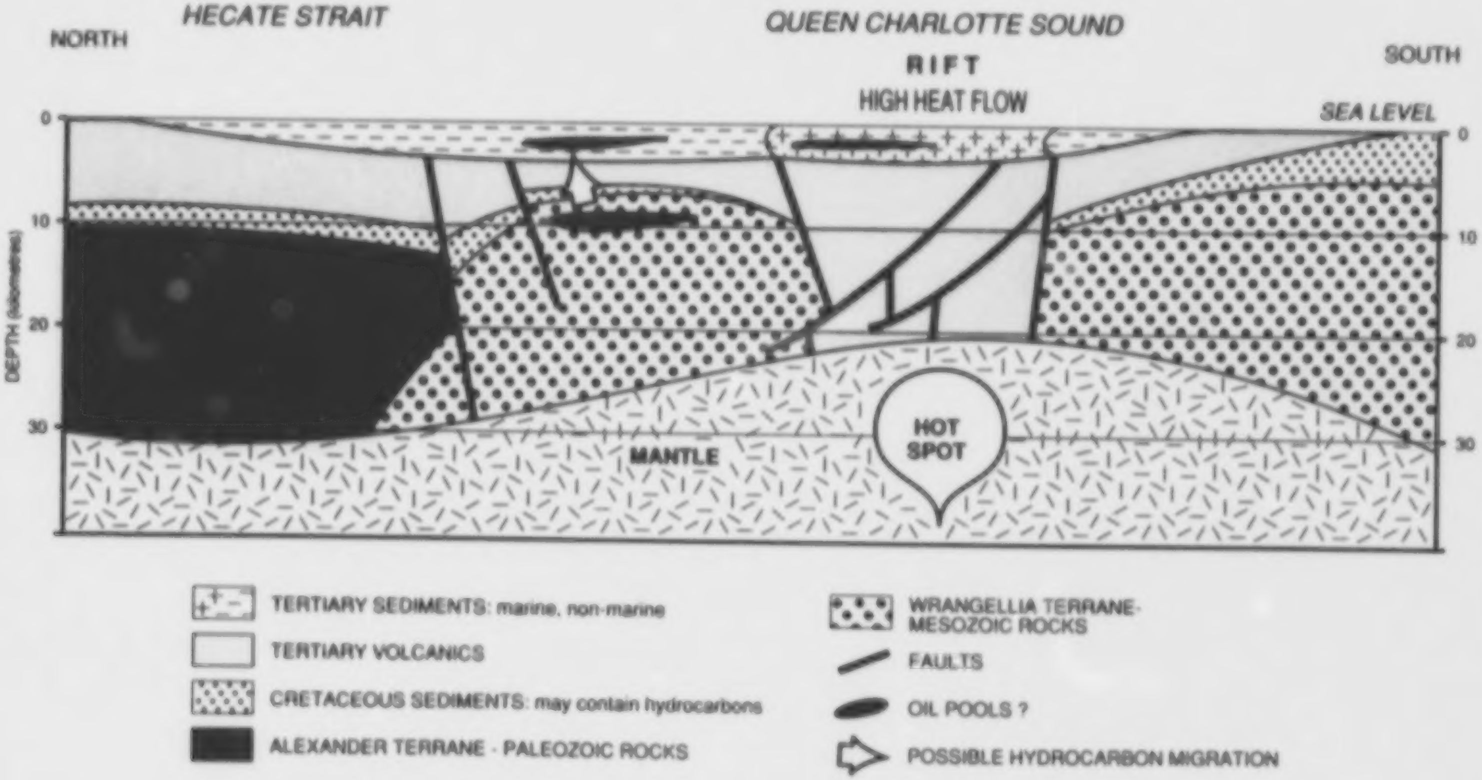

HECATE STRAIT
NORTH
QUEEN CHARLOTTE SOUND
RIFT
HIGH HEAT FLOW
SOUTH
SEA LEVEL
DEPTH (kilometres)
0
10
20
30
MANTLE
HOT SPOT
TERTIARY SEDIMENTS: marine, non-marine
TERTIARY VOLCANICS
CRETACEOUS SEDIMENTS: may contain hydrocarbons
ALEXANDER TERRANE - PALEOZOIC ROCKS
WRANGELLIA TERRANE-MESOZOIC ROCKS
FAULTS
OIL POOLS ?
POSSIBLE HYDROCARBON MIGRATION

Figure 104. Schematic cross section through Queen Charlotte basin (after Yorath & Cameron 1982)

While the eight exploratory wells drilled by Shell Canada Limited between 1967 and 1969 demonstrated that the Tertiary sediments of the Queen Charlotte basin fulfil the basic prerequisites which favour the presence of hydrocarbons, no significant hydrocarbon accumulations were encountered in any of the offshore wells (Anon. 1982). Small evidences, or "shows", of hydrocarbon have been encountered in the form of oil staining in rock samples, or a minor build-up of natural gas in the drilling mud during drilling.

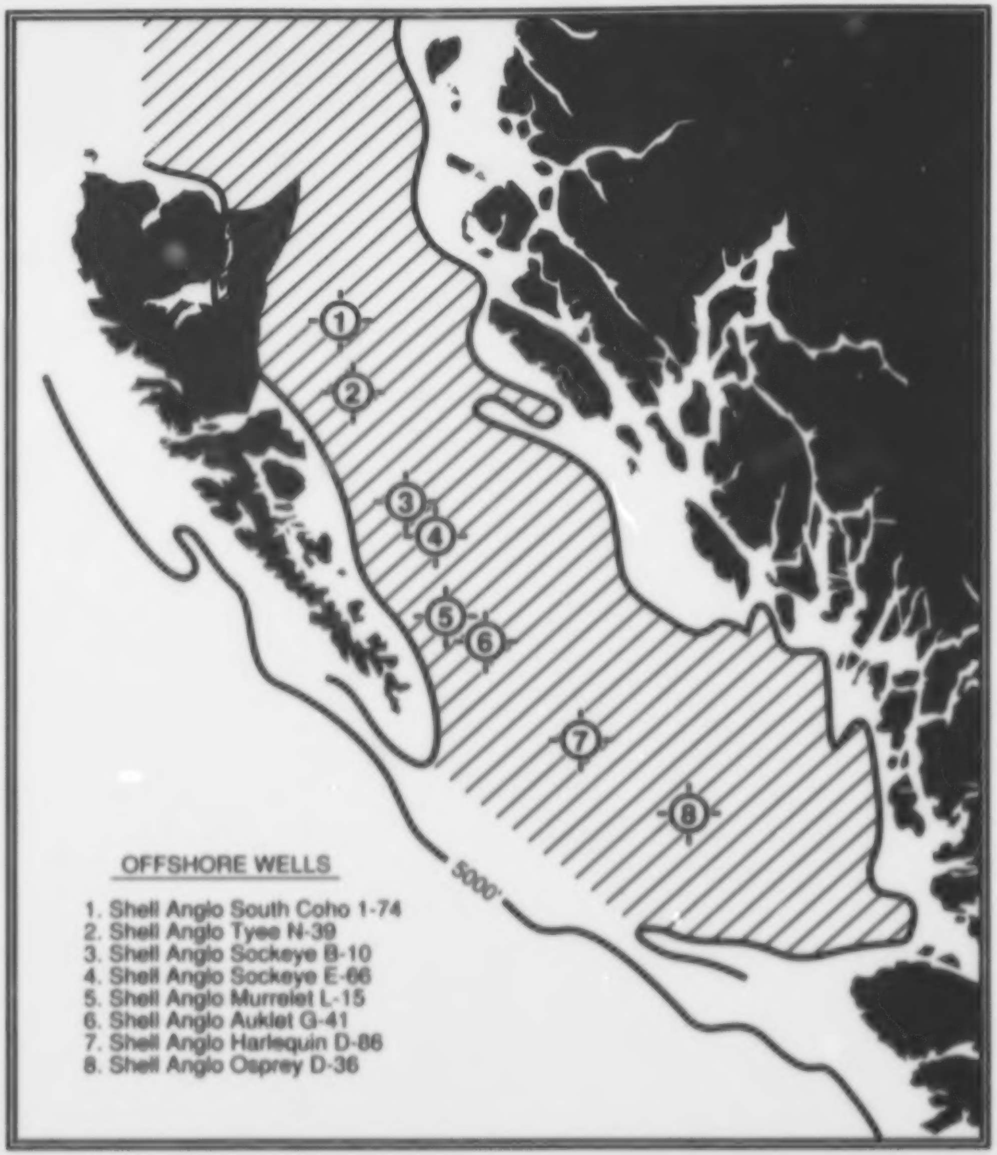

1
2
3
4
5
6
7
8
5000'
OFFSHORE WELLS
1. Shell Anglo South Coho 1-74
2. Shell Anglo Tyee N-39
3. Shell Anglo Sockeye B-10
4. Shell Anglo Sockeye E-66
5. Shell Anglo Murrelet L-15
6. Shell Anglo Auklet G-41
7. Shell Anglo Harlequin D-86
8. Shell Anglo Osprey D-36

Figure 105. Locations of wells drilled offshore in Queen Charlotte Basin (after Anon. 1982)

WELLS DRILLED OFFSHORE IN QUEEN CHARLOTTE BASIN (Anon. 1982)

WELL NAME	NTS LOCATION	TYPE OF HYDROCARBON EVIDENCE
Shell Anglo Tyee N-39	53°18′54.51" N 131°20′21.42" W	Appearance of ethane gas and minor propane gas noted in drilling mud.
Shell Anglo Sockeye B-10	52°49′08.53" N 131°00′44.19" W	Sandstone with heavy brown oil staining. Sandstone with mottled dark brown oil staining and live oil. Sandstone with fair brown oil staining. Sandstone with possible light oil staining. Appearance of methane, ethane, propane and butane gases in drilling mud.
Shell Anglo Sockeye E-66	52°45′24.62" N 130°55′19.44" W	None.
Shell Anglo Auklet G-41	52°20′16.12" N 130°36′22.77" W	None.
Shell Anglo Osprey D-36	51°35′06.20" N 129°20′47.65" W	None.
Shell Anglo Harlequin D-86	51°55′03.38" N 129°58′12.35" W	Increase in the amount of methane gas in the drilling mud. Appearance of minor amounts of ethane and propane in the drilling mud.
Shell Anglo South Coho I-74	53°33′32.6" N 131°25′48.9" W	Siltstone with light brown oil staining.
Shell Anglo Murrelet L-15	52°24′41.3" N 130°47′38.0" W	Siltstone saturated with dark brown dead oil.

Shell Canada Limited is also responsible for providing what knowledge there is today of the magnetic features of the west coast offshore area of Canada (Shouldice 1971). Whereas the major total-intensity aeromagnetic anomalies in the Tofino Basin off the west coast of Vancouver Island tend to be linear and parallel to the Island, the aeromagnetic pattern within the Queen Charlotte Basin is one of broad, lobate, forked anomalies, the result of variations in the thickness of Tertiary sediments. A weak trend of anomalies joins Vancouver Island and the Queen Charlotte Islands. Mariners have reported local magnetic anomalies as great as 50° (Anon. 1987b).

The geological and tectonic history of the Queen Charlotte Islands region not only accounts for its present character, but makes it one of the most active areas in Canada in terms of seismicity.

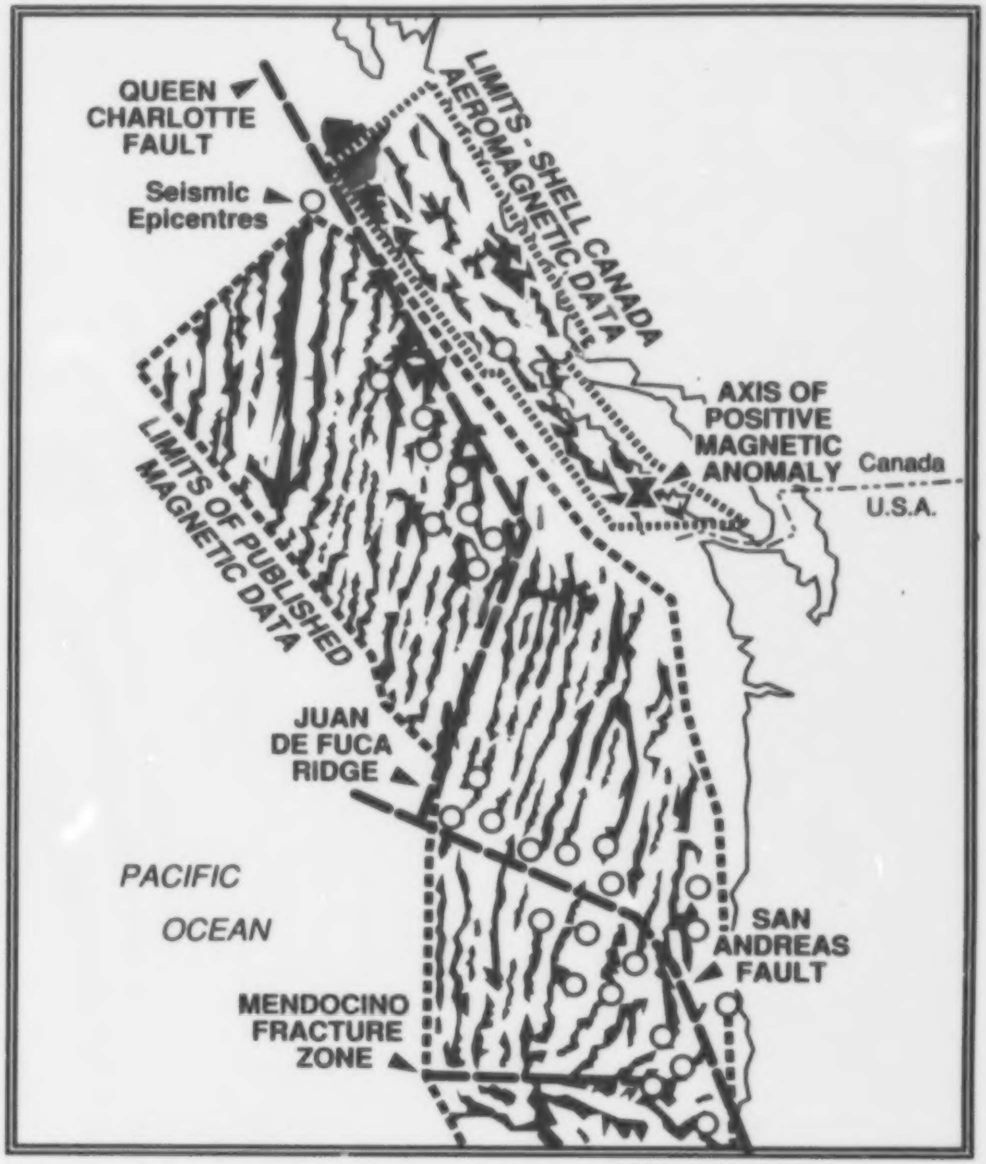
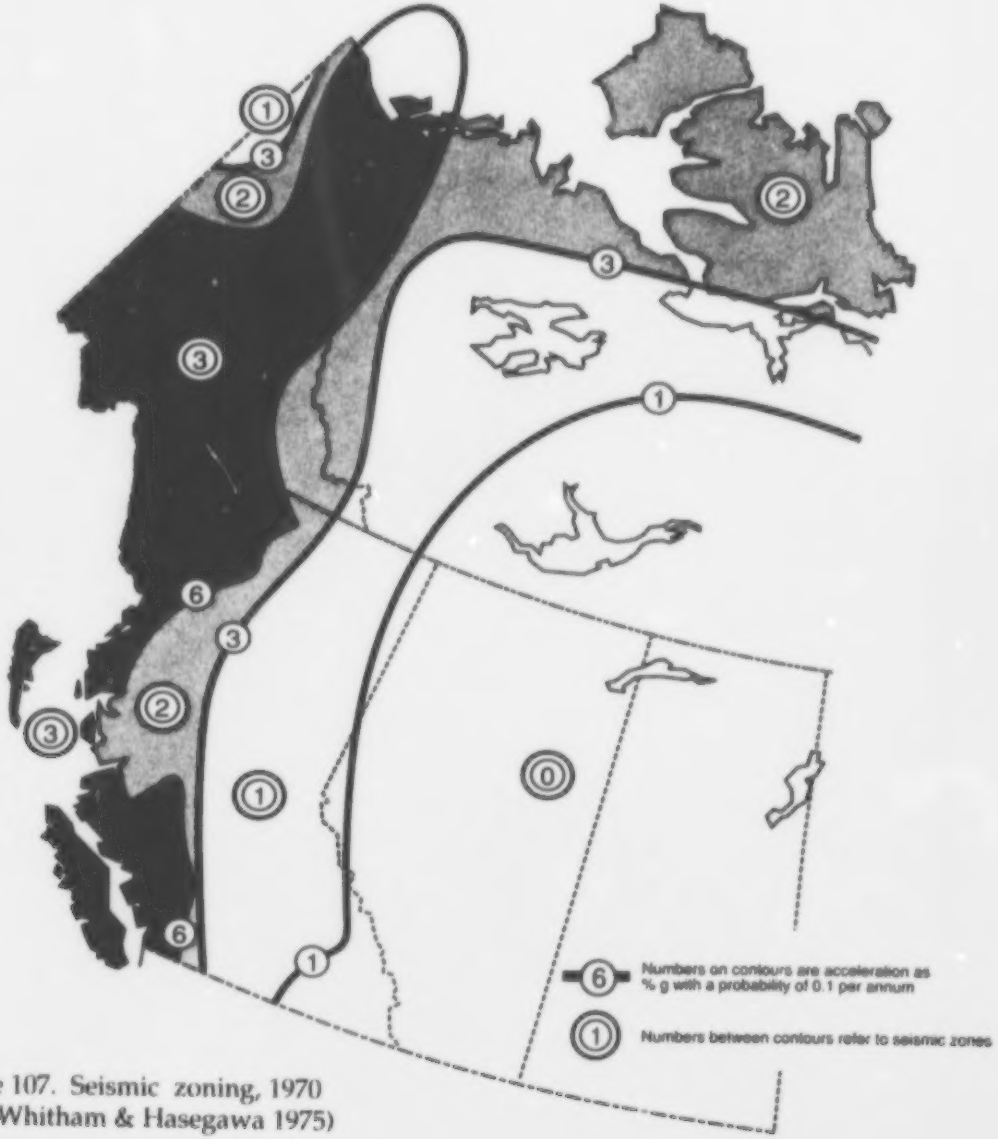

QUEEN CHARLOTTE FAULT
Seismic Epicentres
LIMITS - SHELL CANADA AEROMAGNETIC DATA
AXIS OF POSITIVE MAGNETIC ANOMALY
Canada
U.S.A.
LIMITS OF PUBLISHED MAGNETIC DATA
JUAN DE FUCA RIDGE
PACIFIC OCEAN
SAN ANDREAS FAULT
MENDOCINO FRACTURE ZONE

Figure 106. Regional magnetic map, West Coast offshore (after Shouldice 1971)

The causes of the earthquakes are the movements of previously described fault systems as well as the movements of Canada's active western continental margin which overlaps the boundaries of several mobile tectonic plates (Anon. 1983a). While the Pacific Plate may be underthrusting the North America Plate, there is no certain evidence of deep-focus earthquakes (Weichert & Hyndman 1982). In fact, the focal depths of earthquakes in the area are mostly uncertain, though the main concentration of recent epicentres have been within 25 kilometres of the trace of the Queen Charlotte Fault (Weichert & Hyndman 1981). The maximum magnitude of earthquakes associated with that fault is estimated to be in the vicinity of 8.3 on the Richter Scale. Earthquakes associated with the movement of the Explorer-Juan de Fuca plates might be expected to reach 6.8 on the Richter Scale, while those associated with the deformation of the plates themselves might be expected to be less severe. Seismic activity has a further implication for the marine environment which may impinge heavily upon the landscape: earthquakes can cause Tsunamis, seismic sea waves with little effect upon the seabed but with potentially catastrophic effect upon the shore.


①
③
②
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②
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⑥
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③
①
⓪
⑥
①
⑥ Numbers on contours are acceleration as % g with a probability of 0.1 per annum
① Numbers between contours refer to seismic zones

Figure 107. Seismic zoning, 1970
(after Whitham & Hasegawa 1975)

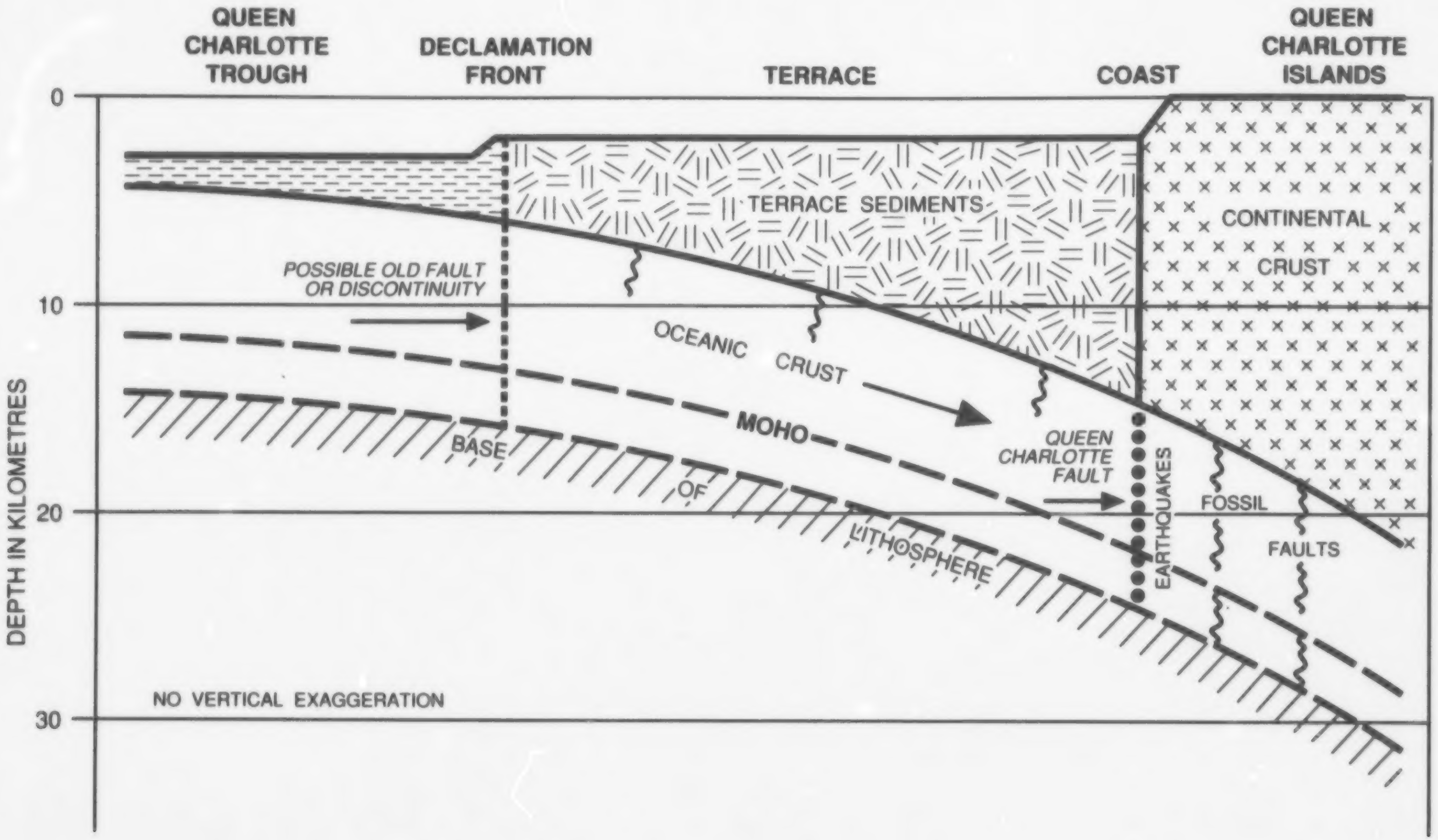
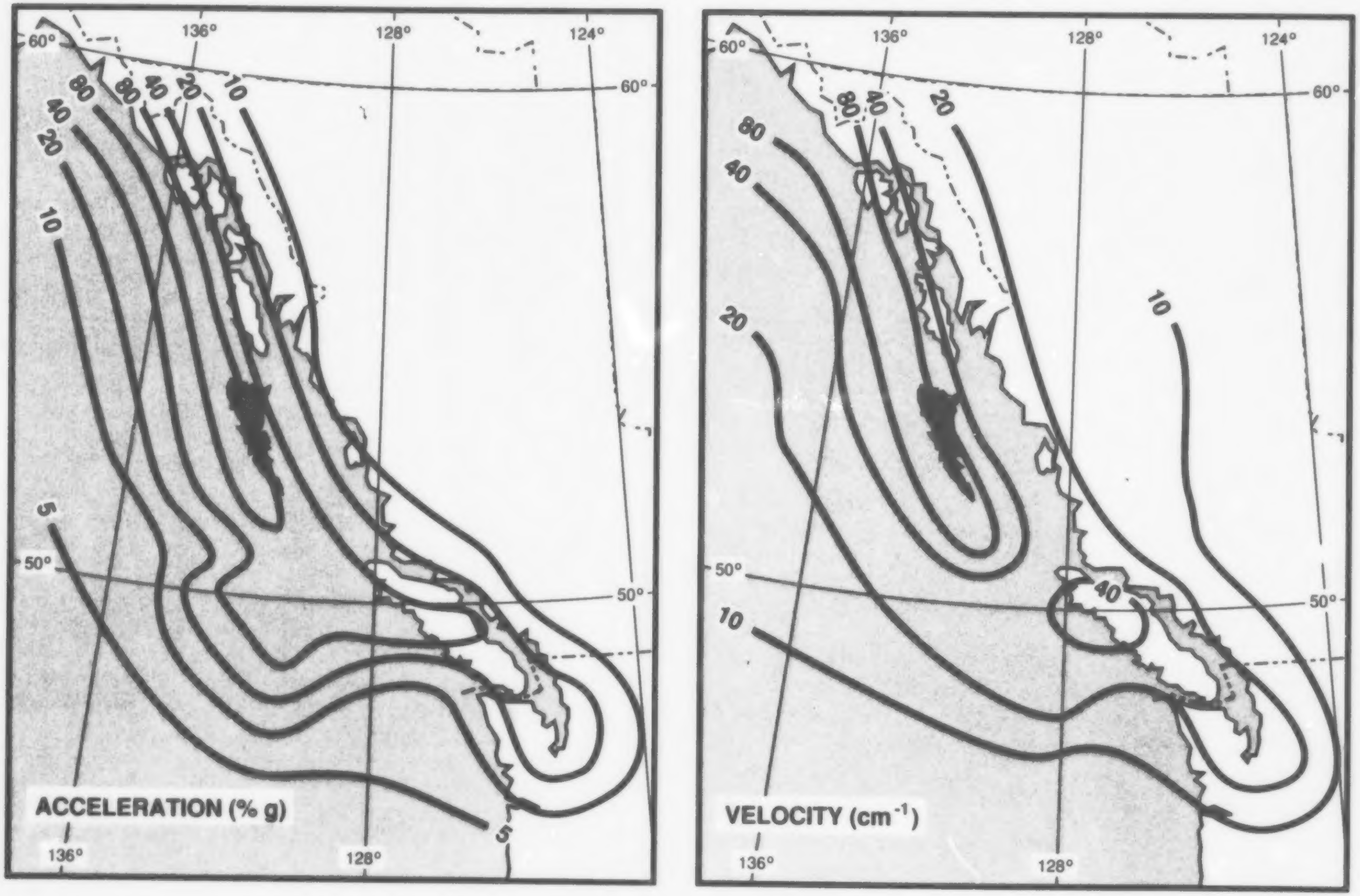

QUEEN CHARLOTTE TROUGH
DECLAMATION FRONT
TERRACE
COAST
QUEEN CHARLOTTE ISLANDS
0
10
20
30
DEPTH IN KILOMETRES
TERRACE SEDIMENTS
CONTINENTAL CRUST
POSSIBLE OLD FAULT OR DISCONTINUITY
OCEANIC CRUST
MOHO
BASE OF LITHOSPHERE
QUEEN CHARLOTTE FAULT
EARTHQUAKES
FOSSIL FAULTS
NO VERTICAL EXAGGERATION

Figure 108. Tectonic model of the west coast of the Queen Charlotte Islands (after Weichert &Hyndman 1982)



60°
136°
128°
124°
60°
80
40
20
10
80
40
20
10
5
50°
50°
5
ACCELERATION (% g)
136°
128°
60°
136°
128°
124°
60°
80
40
20
80
40
20
10
40
50°
50°
10
VELOCITY (cm⁻¹)
136°
128°

Figure 109. Contours of peak acceleration and peak velocityof seismic ground motion expected at a probability of one in ten over 50 years (after Basham et al. 1982)

Changes in the shoreline of British Columbia have been due not only to tectonic activity but to glacial activity as well (Clague *et al* . 1982). Unlike coasts on the mainland and Vancouver Island, the shorelines of the Queen Charlotte Islands were low during Late Pleistocene time and high during most of the Holocene epoch. The relative sea level was likely about 15 metres above the present one at the end of the Pleistocene epoch, about 7,500-8,000 years ago, and the emergence of the landmass has continued, much of it in the last 5,000-6,000 years (Anon. 1983a).

Direction and Cause of Relative Sea Level Changes in the Queen Charlotte Islands (after Clague et al . 1982)

Age:	Relative Sea-Level Change:	Controlling Factors:
Late Pleistocene to Early Holocene	Sea rising	Eustatic rise* Forebulge collapse* Tectonic uplift
Middle Holocene	Sea stable to slightly falling	Tectonic uplift* Eustatic rise* Forebulge collapse
Late Holocene	Sea falling	Tectonic uplift* Eustatic rise

*Dominant controlling factor

a) RESOURCE ANALYSIS

- Management Concerns

The uniqueness, complexity and dynamism which are so much a part of the terrestrial geological resource also characterize the marine geological resource. Recognizing that the same features which make the marine component of SouthMoresby/Gwaii Haanas National Park Reserve outstanding amongst all of the marine units in the National Parks System, also make for a better potential source of petroleum. Several oil exploration interests have in recent years invested in careful research of the area.

There exist a number of geologial and geotechnical hazards with marine origins which may have consequences for both the sea and the shore. Sea quakes, tsunamis, and unstable bottoms of gravels and sands, have been documented in the area of the reserve. The mechanisms of transport and deposition are constantly changing the appearance of the seabed and that of the shoreline. Magnetic anomalies pose navigational concerns, and their presence would seem to indicate a largely unexplored mineral presence beneath the sea.

That the knowledge of marine geological and geotechnical features which may pose management concerns is often thematic and site-specific should suggest that there is room for improvement in the data base, but sufficient information exists that managers can be alert to the kinds of features which warrant monitoring and further study.

Unlike the terrestrial geological situation, there is but one marine geological resource which may admit of extraction: petroleum. The presence of economically extractable petroleum resources beneath the seabed is as yet, however, unconfirmed. Moreover, the status of the national marine park reserve is at present provisional. Declaration of the marine component of the South Moresby/Gwaii Haanas National Park Reserve as a national marine park is several years in the future.

The presence of exploitable minerals is as well unconfirmed other than by the existence of magnetic anomalies. Not only are the anomalies themselves cause for concern, but the possibility that mineral exploration may take place in the future is a consideration for managers.

Another aspect of the marine geological resource which is subject to exploitation, though not extraction, is the the submarine landscape; the visual resource. In order to assure the safe enjoyment of that resource, a full mapping of the undersea landscape within the boundaries of the proposed national marine park reserve is necessary. The status of the sea and the seabed within the boundaries of the national marine park reserve will have a bearing on the manner in which the resource can be understood and enjoyed by the public.

From the point of view of public safety, one of the more serious management concerns must be the active nature of the seismic regime. No other area in Canada is so active. Both the frequency and the intensity of earthquakes in the Queen Charlotte Islands region deserve careful consideration. Unstable sediments on the seabed are easily subject to dramatic shifts with the shock of a seaquake. Tsunamis produced as a result of such seismic activity may have little consequence for the marine environment, but can have a catastrophic effect on shore.

- Status of Knowledge

The bulk of our current knowledge of the marine geological resource is directly or indirectly due to interest in the possible extraction of oil from beneath the sea bed. In consequence, this knowledge is thematic and is focused largely on the area with the greatest likelihood of producing extractable oil, the Queen Charlotte Basin. Knowledge of the Continental shelf and slope is far more limited. The discovery of a major seamount off the west coast of the Queen Charlotte Islands was announced as recently as 1971 (Mammerickx & Taylor; Anon.). Because the examination of the seabed is not a systematic, recurring effort, the changes taking place on the seabed due to the action of seaquakes, transport, and deposition have not been recorded.

The nature of submarine faulting and seismicity is incompletely understood. Recent earthquakes have been located to an accuracy of within 25 kilometres, but the depth of the source is unknown (Weichert & Hyndman 1981). A seismic station was only established in the Queen Charlotte Islands in 1970 (Anon. 1983a). Prior to that, the closest station was in Port Hardy (established in the 1960's). Stations at Port Alberni and Horseshoe Bay go back to 1951, and the Victoria station had been capable of detecting earthquakes in the Queen Charlotte Islands area since 1948.

Magnetic anomalies go largely unmapped and rely upon the irregular reports of mariners for their substantiation. It is not known whether the sources of the anomalies may be exploitable mineral resources.

b) SELECT REFERENCE SOURCES

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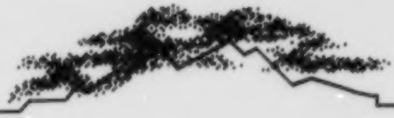
V.
SOIL RESOURCES

SOIL RESOURCES



General Overview

Soil is a naturally occurring interface between climate-, geological-, and biotic processes, usually requiring considerable time to form. Agriculture Canada (Anon. 1976) defined the standard meaning of the the pedological term "soil"; *i.e.*

The naturally occurring unconsolidated material on the surface of the earth that has been influenced by parent material, climate (including the effects of moisture and temperature), macro- and micro-organisms, and relief, all acting over a period of time to produce soil that may differ from the material from which it was derived in many physical, chemical, mineralogical, biological, and morphological properties.

More specifically, Jenny (1940, 1980) described a group of environmental variables collectively referred to as "soil-forming factors" (f), from which he formulated the following mathematical expression:

Soil = f (climate, parent material, flora influx, topography, age)

Of these factors, soil climate, expressed in terms of soil temperature and soil moisture, is perhaps the best indicator of the current state of soil development and productivity levels. Therefore, and following the conventions of the Soil Climate Classification for North America (FAO/UNESCO), the area contained in the South Moresby/Gwaii Haanas National Park Reserve and the Queen Charlotte Islands for the most part, fall into the following soil temperature class and soil moisture sub-class, respectively:

Soil Temperature Class: COLD CRYOBOREAL

COLD TO MODERATELY COLD

- Mean annual soil temperature = 2 to <8 ° C
- Mean summer soil temperature = 8 to <15 ° C
- Growing season (>5 ° C) = 120 to 180 days
- Growing season degree days* (>5 ° C) = 555 to <1110
- Thermal period (>15 ° C) = no significant days
- Thermal period days (>15 ° C) = <33

Soil Moisture Class: PERHUMID

MOIST UNSATURATED REGIMES

- Soil moist all year, seldom dry
- No significant water deficits in the growing season
- Water deficits 0 to <2.5 cm
- Climatic Moisture Index (CMI)** = >84

Note:

* Degree Days = the difference between the mean daily temperature and a selected standard temperature, accumulated daily over a period of time, such as the growing season.

** CMI = Climatic Moisture Index which expresses the growing season precipitation as a percentage of the potential water used by annual crops, when water is readily available from the soil.

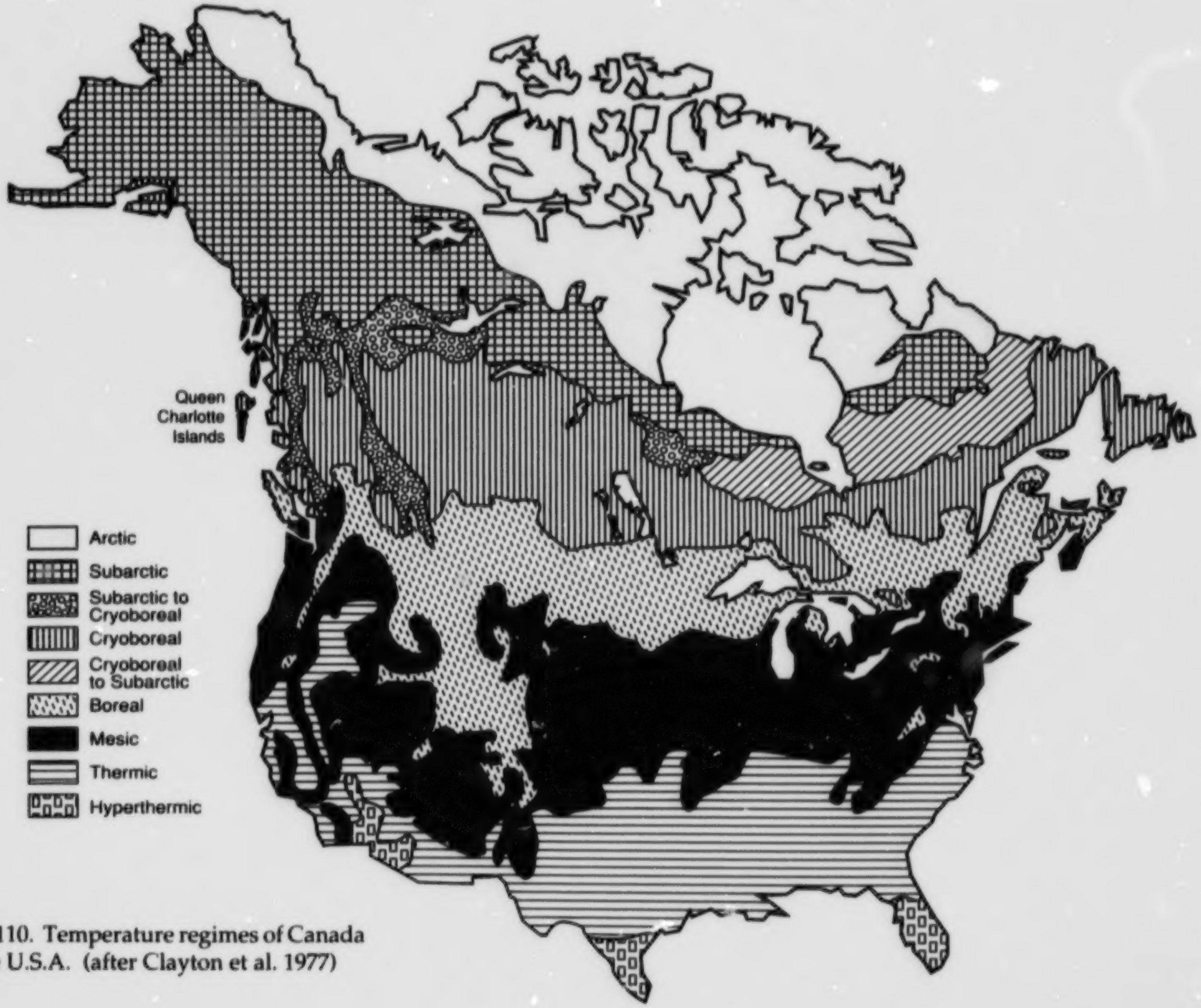

Queen
Charlotte
Islands
Arctic
Subarctic
Subarctic to Cryoboreal
Cryoboreal
Cryoboreal to Subarctic
Boreal
Mesic
Thermic
Hyperthermic

Figure 110. Temperature regimes of Canada and the U.S.A. (after Clayton et al. 1977)

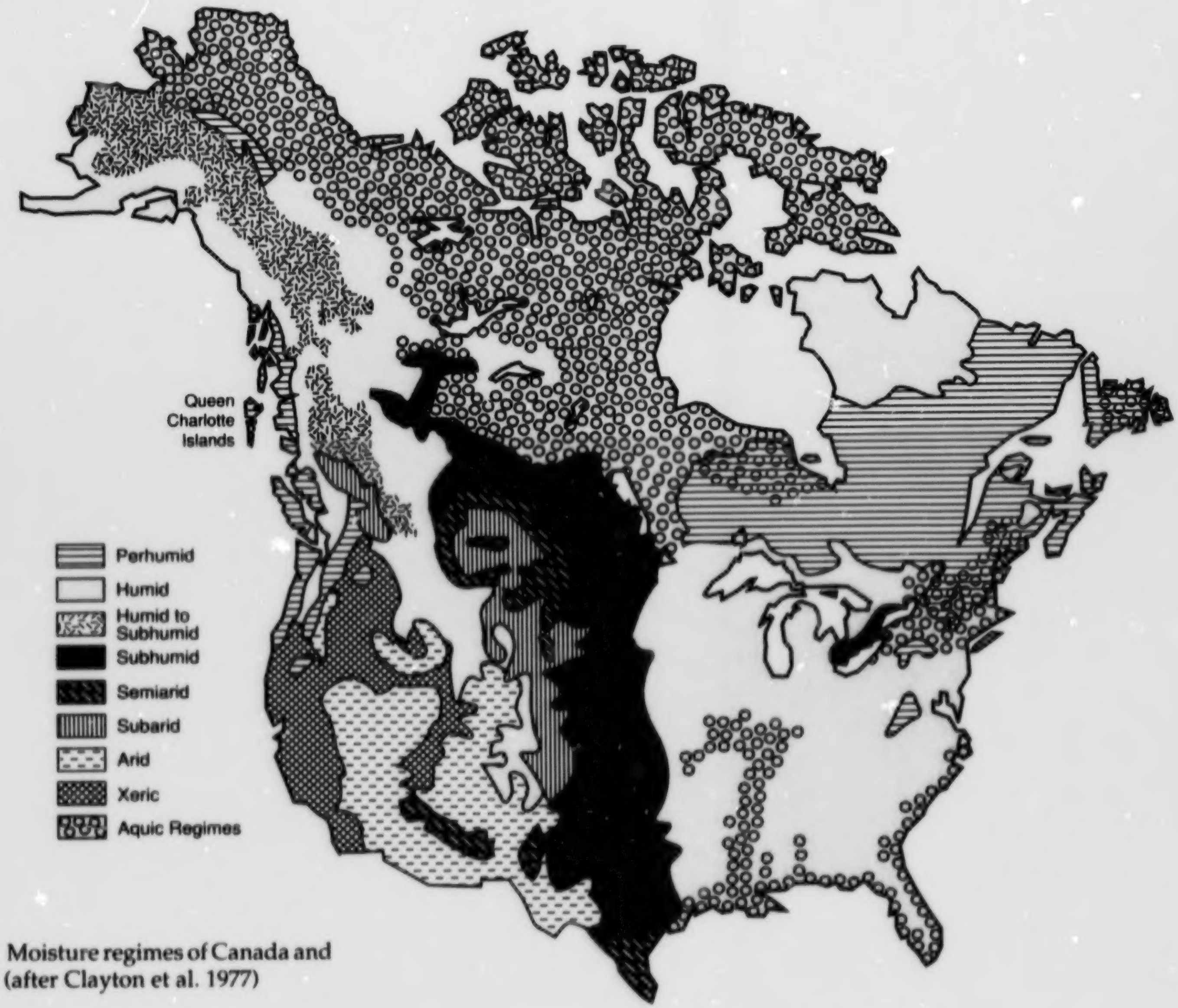

Queen Charlotte Islands
Perhumid
Humid
Humid to Subhumid
Subhumid
Semiarid
Subarid
Arid
Xeric
Aquic Regimes

Figure 111. Moisture regimes of Canada and the U.S.A. (after Clayton et al. 1977)

In the context of Canada's major soil zones and regions (Rowe 1972), the general coastal area from the International Boundary and Vancouver Island northwestward to the Queen Charlotte Islands, is referred to as the Pacific Coast Forest Region. The prevailing climatic regime has caused soils to develop under Boreal and Cryoboreal perhumid to humid conditions, that are strongly modified by the maritime influence and the long growing season (Clayton *et al.* 1977).

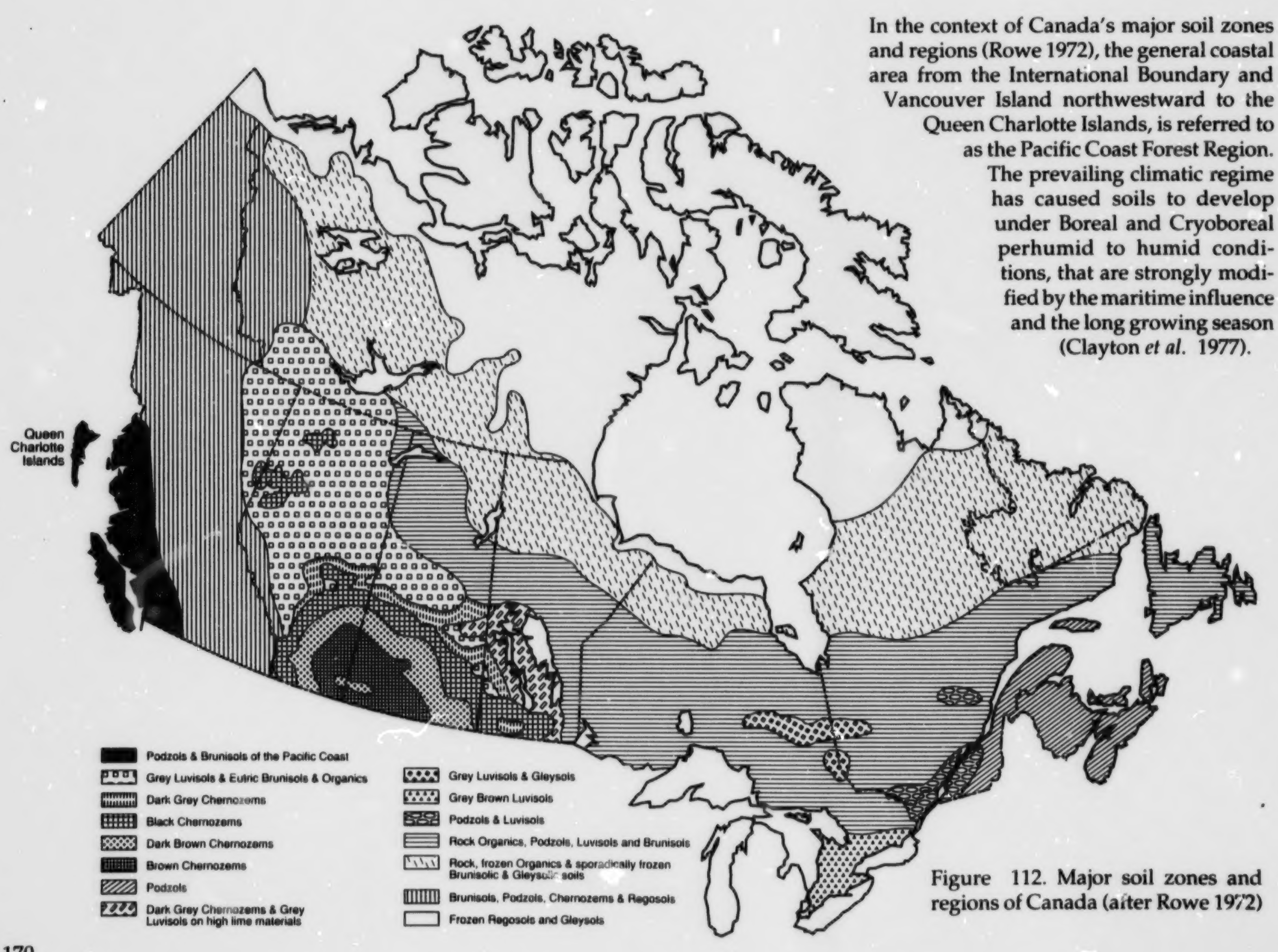

Queen Charlotte Islands
Podzols & Brunisols of the Pacific Coast
Grey Luvisols & Eutric Brunisols & Organics
Dark Grey Chernozems
Black Chernozems
Dark Brown Chernozems
Brown Chernozems
Podzols
Dark Grey Chernozems & Grey Luvisols on high lime materials
Grey Luvisols & Gleysols
Grey Brown Luvisols
Podzols & Luvisols
Rock Organics, Podzols, Luvisols and Brunisols
Rock, frozen Organics & sporadically frozen Brunisolic & Gleysolic soils
Brunisols, Podzols, Chernozems & Regosols
Frozen Regosols and Gleysols

Figure 112. Major soil zones and regions of Canada (after Rowe 1972)

Most upland soils in the Pacific Coast Forest Region consist of Podzols, Brunisols, Gray Luvisols, rocklands, and lithic phases of various soils, all of which are highly productive on moist forest sites. Clayton *et al.* (1977) provided a broad-scale map overview of the dominant soils occurring on the Queen Charlotte Islands and elsewhere, and described them to be primarily Humo-Ferric Podzols with significant stony and lithic phases, that have developed on dominantly rolling, hilly, to steeply mountainous landscapes.

The soil information available for the Islands is for the most part the result of forest practice-related studies conducted primarily by the British Columbia Ministry of Forests, MacMillan Bloedel Ltd., Crown Zellerbach Canada Ltd., and Western Forest Products Ltd. The literature reviewed to this point in time, makes no mention of specific soil studies or inventories, and soil information about the area contained in the South Moresby/ Gwaii Haanas National Park Reserve seems to be particularly scarce. It is also important to note that the soil descriptions available to park- and resource managers are broadly-based generalizations of soil types and conditions extrapolated from biogeoclimatic and forest ecosystem descriptions of earlier workers like Krajina (1959, 1970) and others.

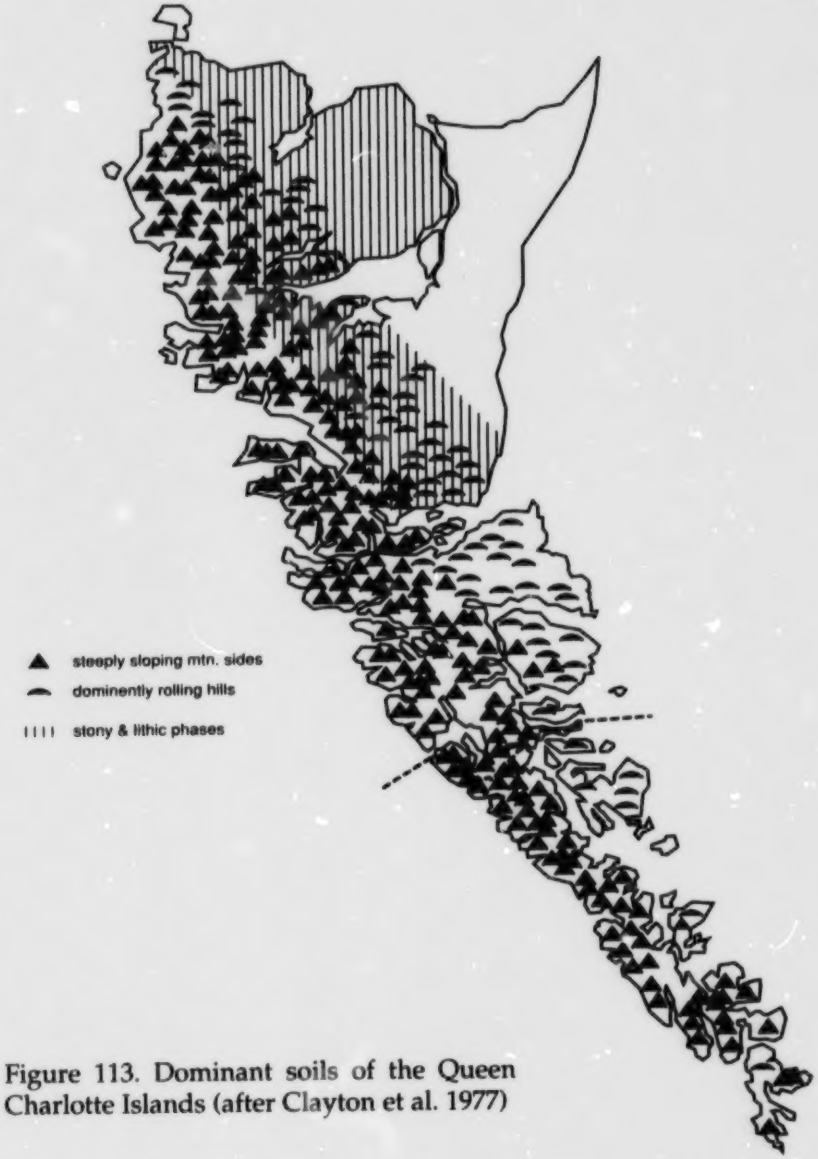


Figure 113. Dominant soils of the Queen Charlotte Islands (after Clayton et al. 1977)

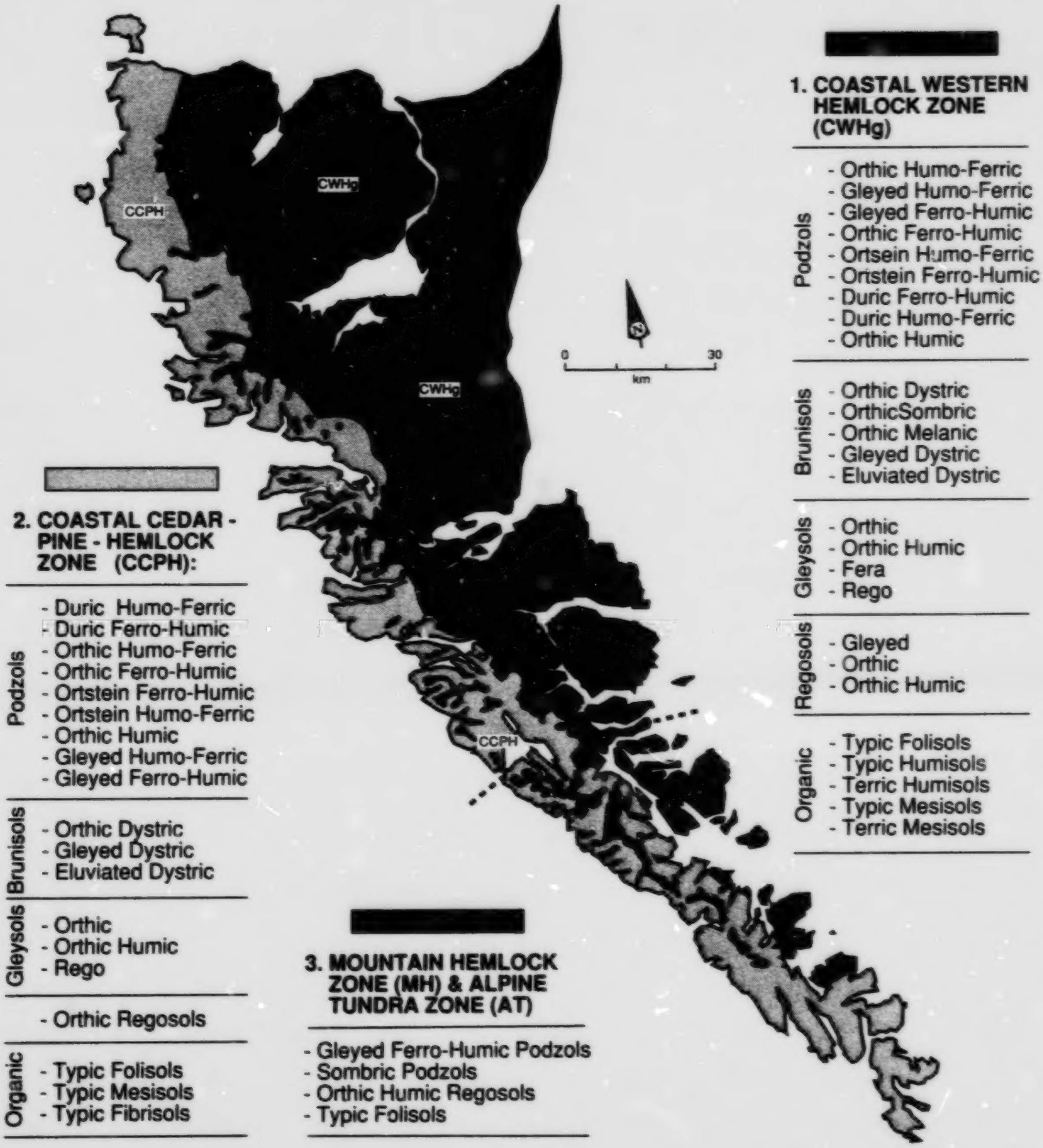

1. COASTAL WESTERN HEMLOCK ZONE (CWHg)
Podzols
- Orthic Humo-Ferric
- Gleyed Humo-Ferric
- Gleyed Ferro-Humic
- Orthic Ferro-Humic
- Ortsein Humo-Ferric
- Ortstein Ferro-Humic
- Duric Ferro-Humic
- Duric Humo-Ferric
- Orthic Humic
Brunisols
- Orthic Dystric
- OrthicSombric
- Orthic Melanic
- Gleyed Dystric
- Eluviated Dystric
Gleysols
- Orthic
- Orthic Humic
- Fera
- Rego
Regosols
- Gleyed
- Orthic
- Orthic Humic
Organic
- Typic Folisols
- Typic Humisols
- Terric Humisols
- Typic Mesisols
- Terric Mesisols
2. COASTAL CEDAR - PINE - HEMLOCK ZONE (CCPH):
Podzols
- Duric Humo-Ferric
- Duric Ferro-Humic
- Orthic Humo-Ferric
- Orthic Ferro-Humic
- Ortstein Ferro-Humic
- Ortstein Humo-Ferric
- Orthic Humic
- Gleyed Humo-Ferric
- Gleyed Ferro-Humic
Brunisols
- Orthic Dystric
- Gleyed Dystric
- Eluviated Dystric
Gleysols
- Orthic
- Orthic Humic
- Rego
- Orthic Regosols
Organic
- Typic Folisols
- Typic Mesisols
- Typic Fibrisols
3. MOUNTAIN HEMLOCK ZONE (MH) & ALPINE TUNDRA ZONE (AT)
- Gleyed Ferro-Humic Podzols
- Sombric Podzols
- Orthic Humic Regosols
- Typic Folisols
CWHg
CWHg
CCPH
CCPH
N
0
30
km

Figure 114. Generalized soil associations based on bioclimatic zones and their vegetation associations (modified from Banner et al. 1989)

TERRESTRIAL SOIL RESOURCES

Banner *et al.* (1989) of the British Columbia Ministry of Forests are the only known authors to have provided a generalized statement about the presence of certain soil subgroups that developed under West Coast climatic regimes and vegetation associations.

The same authors determined that podzolic soils are the most widespread soil order (Anon. 1978c) on the Queen Charlotte Islands, even though brunisolic, gleysolic, regosolic, and organic soils are present to varying degrees. Soil-forming processes in the wetter mountainous areas of the Islands are dependent upon the closeness of bedrock to the surface, steep slopes, active geomorphic processes, and poor drainage; while the soil development in the somewhat drier eastern areas, especially of Graham Island, is dominated by the accumulation of organic matter. Areas with organic surface horizons up to 50 cm in depth are common, as are bogs. In the very humid areas of the Islands, blanket bogs have formed on gradients up to 60 percent, and the western flank of Moresby Island is said to contain bogs that extend continuously from "sea level to ridge crests" (Anon. 1988d).

ECOLOGICAL NUTRIENT REGIME

ECOLOGICAL MOISTURE REGIME

		OLIGO-TROPHIC A	SUBMESO-TROPHIC B	MESO-TROPHIC C	PERMESO-TROPHIC D	SUBEUTRO-PHIC TO EUTROPHIC E
VERY XERIC	0					
XERIC	1					
SUBXERIC	2					
SUBMESIC	3					
MESIC	4					
SUBHYGRIC	5					
HYGRIC	6					
SUBHYGRIC SUBEUTRO-PHIC	7					

Figure 115. Edatropic grid of ecological moisture and nutrient regimes (after Haeussler et al. 1984)

Banner *et al.* (1989s) identified the presence of several subgroups of five soil orders under the Canadian System of Soil Classification (Anon. 1978c); *i.e.* subgroups of the Podzol, Brunisol, Gleysol, Regosol, and Organic soil orders. Furthermore, during their field sampling procedures they employed an edatopic grid which was used as an aid to stratification within each biogeoclimatic unit on the Queen Charlotte Islands. The grid was used extensively to establish and display the ecological relationship between the soil nutrient- and soil moisture regimes. A synoptic review of their description of the ecological parameters involved in local soil-forming processes is warranted:

- **THE PODZOLIC ORDER**

Soils of this order are known for their characteristic B horizons which are dominated by an accumulation of amorphous material composed primarily of humified organic matter in combination with varying amounts of Al and Fe.

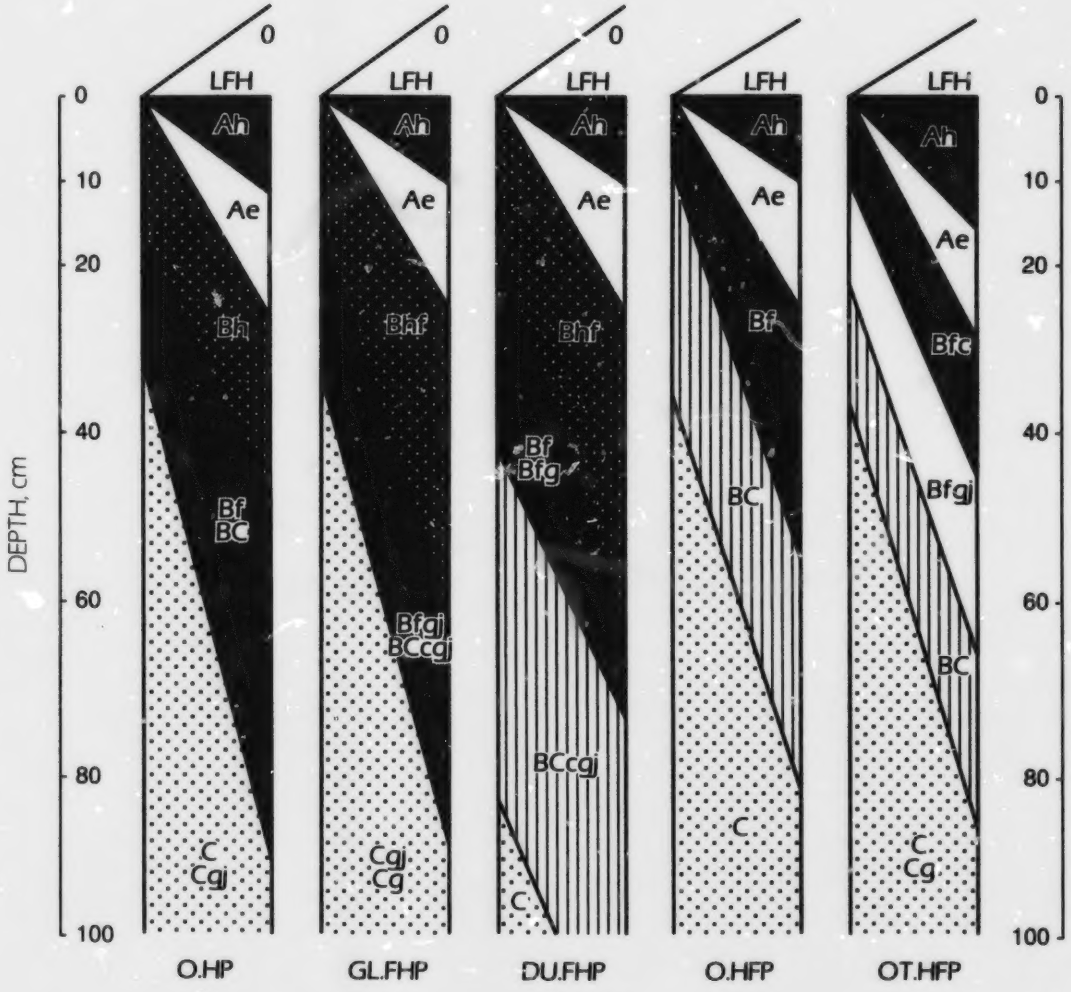

DEPTH, cm
0
10
20
40
60
80
100
0
LFH
Ah
Ae
Bh
Bf
BC
C
Cgj
O.HP
0
LFH
Ah
Ae
Bhf
Bfgj
BCcgj
Cgj
Cg
GL.FHP
0
LFH
Ah
Ae
Bhf
Bf
Bfg
BCcgj
C
DU.FHP
LFH
Ah
Ae
Bf
BC
C
O.HFP
LFH
Ah
Ae
Bfc
Bfgj
BC
C
Cg
OT.HFP
0
10
20
40
60
80
100

Figure 116. Diagrammatic horizon pattern of some subgroups of the Podzolic order (after Anon. 1978c)

1.) Coastal Western Hemlock Biogeoclimatic Zone (CWHg):

- Orthic Humo-Ferric Podzol (O.HFP)
- Orthic Ferro-Humic Podzol (O.FHP)

Landform/ Parent Material = colluvial and morainal blankets/ veneers, beach ridges;
Elevational Range = 0 - 600 m;
Slope Position/Range = level - lower slopes - crests; 0 - 100 %;
Moisture Regime = subhygric - subxeric;
Nutrient Regime = submesotrophic - mesotrophic - permesotrophic;
Vegetation Assoc. = dry cedar - salal; spruce - reedgrass seacoast forests; spruce beach/dune forests; spruce - hemlock - sword fern; zonal hemlock-moss; Montane zonal hemlock - moss; hemlock - spruce - foamflower oak fern; Montane hemlock - cypress - oak fern.

- Gleyed Humo-Ferric Podzol (GL.HFP)
- Gleyed Ferro-Humic Podzol (GL.FHP)

Landform/ Parent Material = marine beach gravels and sands; morainal and colluvial blankets/ veneers;
Elevational Range = 0 - 350 (+) m;
Slope Position/Range = level - crests; 0 - 85 %;
Moisture Regime = submesic - hygric;
Nutrient Regime = submesotrophic - mesotrophic - permesotrophic;
Vegetation Assoc. = spruce beach/dune forests; zonal hemlock moss; Montane zonal hemlock moss; hemlock - spruce - foamflower - oak fern; Montane hemlock - cypress - oak fern; Montane hemlock - cypress - false hellebore - liverwort.

- Duric Humo-Ferric Podzol (DU.HFP)
- Duric Ferro Humic Podzol (DU.FHP)

Landform/ Parent Material = morainal and colluvial veneers;
Elevational Range = <350 - 600 m;
Slope Position/Range = middle lower slopes - crests; <15 - 75 %;
Moisture Regime = subhygric - mesic;
Nutrient Regime = submesotrophic - mesotrophic;
Vegetation Assoc. = Montane zonal hemlock - moss; cedar - hemlock - salal;

- Ortstein Humo-Ferric Podzol (OT.HFP)
- Ortstein Ferro-Humic Podzol (OT.FHP)

Landform/ Parent Material = morainal and colluvial blankets/ veneers;
Elevational Range = 0 - >350 m;
Slope Position/Range = lower slopes - crests; 0 - 75 %;
Moisture Regime = subhygric - mesic;
Nutrient Regime = oligotrophic - permesotrophic;
Vegetation Assoc. = zonal hemlock - moss; Montane hemlock - cypress - oak fern;

1.) Coastal Western Hemlock Biogeoclimatic Zone (CWHg) continued

- Orthic Humic Podzol (O.HP)

Landform/
Parent Material = morainal and colluvial veneers;
Elevational Range = <350 - 600 m;
Slope Position/Range = lower slopes - crests; 15 - 75 %;
Moisture Regime = subhygric - mesic;
Nutrient Regime = mesotrophic - permesotrophic;
Vegetation Assoc. = Montane zonal hemlock - moss; Montane hemlock - cypress - oak fern;

2.) Coastal Cedar - Pine - Hemlock Biogeoclimatic Zone (CCPH):

- Orthic Humo-Ferric Podzol (O.HFP)
- Orthic Ferro-Humic Podzol (O.FHP)

Landform/
Parent Material = colluvial and morainal veneers/ blankets over bedrock;
Elevational Range = 0 - 600 m;
Slope Position/Range = lower - upper slopes; n 0 - 100 %;
Moisture Regime = subhygric - mesic;
Nutrient Regime = submesotrophic - permesotrophic;
Vegetation Assoc. = submesic cedar - cypress - hemlock - shore pine - salal - moss; zonal cedar - cypress - hemlock - Vaccinium - salal - moss; hemlock - cedar - spruce - oam flower - oak fern - lady fern; spruce - salal - reedgrass seacoast forest; hemlock - cedar - Vaccinium - (deer fern) - moss;

- Gleyed Humo-Ferric Podzol (GL.HFP)
- Gleyed Ferro-Humic Podzol (GL.FHP)

Landform/
Parent Material = colluvial and morainal veneers/ blankets;
Elevational Range = 0 - 600 m;
Slope Position/Range = lower - upper slopes; 20 - 80 %;
Moisture Regime = subhygric - mesic;
Nutrient Regime = mesotrophic - permesotrophic;
Vegetation Assoc. = zonal cedar - cypress - hemlock - Vaccinium - salal - moss; hemlock - cedar - spruce - foam flower - oak fern - lady fern;

2.) Coastal Cedar - Pine - Hemlock Biogeoclimatic Zone (CCPH): continued

- Duric Humo-Ferric Podzol (DU.HFP)
- Duric Ferro Humic Podzol (DU.FHP)

Landform/ Parent Material = colluvial and morainal veneers/ blankets;
Elevational Range = 0 - 600 m;
Slope Position/Range = middle slopes - crests, rarely lower slopes; 0 - 60 %;
Moisture Regime = submesic - mesic;
Nutrient Regime = submesotrophic - mesotrophic;
Vegetation Assoc. = zonal cedar - cypress - hemlock - Vaccinium - salal - moss; submesic cedar - cypress - hemlock - shore pine - salal - moss;

- Ortstein Humo-Ferric Podzol (OT.HFP)
- Ortstein Ferro-Humic Podzol (OT.FHP)

Landform/ Parent Material = colluvial and morainal veneers over bedrock;
Elevational Range = 0 - 600 m;
Slope Position/Range = upper slopes and crests; 0 - 60 %;
Moisture Regime = submesic;
Nutrient Regime = submesotrophic;
Vegetation Assoc. = submesic cedar - cypress - hemlock - shore pine - salal - moss;

- Orthic Humic Podzol (O.HP)

Landform/ Parent Material = colluvial and morainal blankets/veneers over bedrock;
Elevational Range = 0 - 600 m;
Slope Position/Range = middle slopes - crests, rarely lower slopes; 0 - 60 %;
Moisture Regime = subhygric - mesic;
Nutrient Regime = oligotrophic - mesotrophic ;
Vegetation Assoc. = submesic cedar - cypress - hemlock - shore pine - salal - moss; zonal cedar - cypress - hemlock - Vaccinium - salal - moss; cedar - cypress - skunk cabbage swamp forest; cedar - cypress - pine bog forest; pine - cypress - cedar - bog woodland; pine - cypress open blanket bog;

3.) Mountain Hemlock Zone (MH)
& Alpine Tundra Zone (AT)

- Gleyed Ferro-Humic Podzol
(GL.FHP)

Landform/
Parent Material =)
Elevational Range =)
Slope Position/Range =) - no information available.
Moisture Regime =)
Nutrient Regime =)
Vegetation Assoc. =)

- Sombric Ferro-Humic Podzol
(SM.FHP)

Landform/
Parent Material =)
Elevational Range =)
Slope Position/Range =) - no information available.
Moisture Regime =)
Nutrient Regime =)
Vegetation Assoc. =)

• THE BRUNISOLIC ORDER

Soils of this order are known for their characteristically brownish Bm horizons, but the order includes soils of various colours, Ae, Btj and/or Bfj horizons

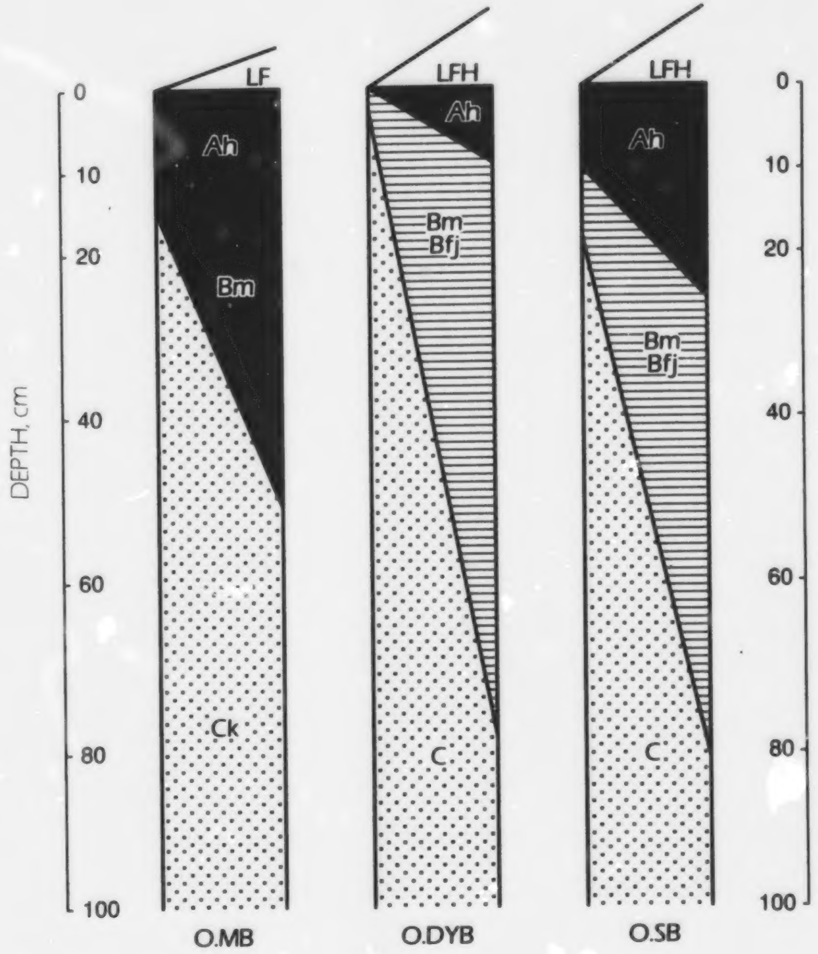

DEPTH, cm
0
10
20
40
60
80
100
LF
Ah
Bm
Ck
O.MB
LFH
Ah
Bm
Bfj
C
O.DYB
LFH
Ah
Bm
Bfj
C
O.SB

Figure 117. Diagrammatic horizon pattern of some subgroups of the Brunisolic order. (after Anon. 1978)

1.) Coastal Western Hemlock Biogeoclimatic Zone (CWHg):

- Orthic Melanic Brunisol (O.MB)

Landform/ Parent Material = colluvial and morainal veneers/ blankets
Elevational Range = 0 - 400 m;
Slope Position/Range = lower - upper slopes; 10 - 75 %;
Moisture Regime = submesic - mesic;
Nutrient Regime = permesotrophic - subeutrophic;
Vegetation Assoc. = spruce hemlock - sword fern;

- Orthic Sombric Brunisol (O.SB)

Landform/ Parent Material = colluvial and morainal veneers/ blankets; recent fluvial blankets;
Elevational Range = 0 - 400 m;
Slope Position/Range = level - upper slopes; 0 - 75 %;
Moisture Regime = subhygric - mesic;
Nutrient Regime = permesotrophic - eutrophic;
Vegetation Assoc. = spruce - hemlock - sword fern; alluvial spruce grass;

- Orthic Dystric Brunisol (O.DYB)

Landform/ Parent Material = colluvial and morainal veneers/ blankets; recent fluvial blankets;
Elevational Range = 0 - 600 m;
Slope Position/Range = level - upper slopes; 0 - 85 %;
Moisture Regime = subhygric - mesic;
Nutrient Regime = permesotrophic - eutrophic;
Vegetation Assoc. = spruce - hemlock - sword fern; alluvial spruce - grass; hemlock - spruce - foamflower - oak fern; Montane zonal hemlock - moss;

- Eluviated Dystric Brunisol (E.DYB)

Landform/ Parent Material = morainal and colluvial blankets/ veneers;
Elevational Range = 0 - 350 m;
Slope Position/Range = lower slopes - crests; 0 - 70 %;
Moisture Regime = mesic;
Nutrient Regime = mesotrophic;
Vegetation Assoc. = zonal hemlock - moss;

1.) Coastal Western Hemlock Biogeoclimatic Zone (CWHg): continued

- Gleyed Dystric Brunisol (GL.DYB)

Landform/
Parent Material = morainal and colluvial blankets/veneers; slope-washed fluvial sediments;
Elevational Range = 0 - 600 m;
Slope Position/Range = lower slopes - crests; 0 -85 %;
Moisture Regime = subhygric - mesic;
Nutrient Regime = permesotrophic - mesotrophic;
Vegetation Assoc. = zonal hemlock - moss; hemlock - spruce - foamflower - oakfern; Montane hemlock - cypress - false hellebore - liverwort;

2.) Coastal Cedar - Pine - Hemlock Biogeoclimatic Zone (CCPH):

- Orthic Dystric Brunisol (O.DYB)

Landform/
Parent Material = colluvial veneers/blankets over bedrock;
Elevational Range = 0 - 600 m;
Slope Position/Range = upper slopes - crests; rarely lower slopes; 0 - 80 %;
Moisture Regime = subxeric - mesic;
Nutrient Regime = oligotrophic - permesotrophic;
Vegetation Assoc. = dry shore pine - juniper - lichen; hemlock - cedar - Vaccinium - (deer fern) - moss; zonal cedar - cypress - hemlock-salal - Vaccinium - moss;

- Gleyed Dystric Brunisol (GL.DYB)

Landform/
Parent Material = morainal and colluvial blankets/veneers;
Elevational Range = 0 - 600 m;
Slope Position/Range = middle - upper slopes; rarely lower slopes; 0 -85 %;
Moisture Regime = subhygric - mesic;
Nutrient Regime = permesotrophic - mesotrophic;
Vegetation Assoc. = zonal hemlock - moss; hemlock -spruce - foamflower - oak fern; Montane hemlock - cypress - false hellebore - liverwort; zonal cedar - cypress - hemlock - Vaccinium - salal - moss;

2.) Coastal Cedar - Pine - Hemlock Biogeoclimatic Zone (CCPH): continued

- Eluviated Dystric Brunisol (E.DYB)

Landform/
Parent Material = morainal veneers/blankets;
Elevational Range = 0 - 600 m;
Slope Position/Range = lower slopes - crests; 0 - 30 %;
Moisture Regime = hygric;
Nutrient Regime = oligotrophic - submesotrophic;
Vegetation Assoc. = pine - cypress - cedar bog woodland;

3.) Mountain Hemlock Zone (MH) & Alpine Tundra Zone (AT)

- No brunisolic soils have been identified to occur in this biogeoclimatic zone.

• THE GLEYSOLIC ORDER

Soils of this order are known to be associated with the presence of a high groundwater table and may be saturated or partly submerged for long periods of time. Most Gleysols contain mottles of hydrated ferric iron.

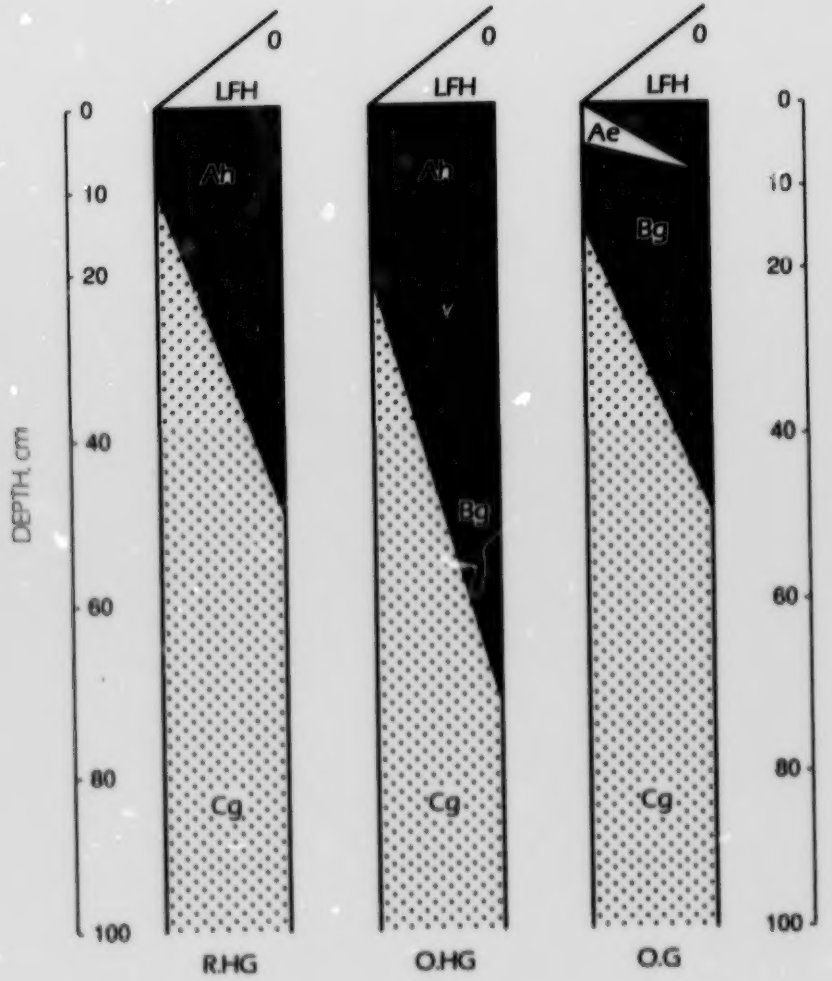

DEPTH, cm
0
10
20
40
60
80
100
0
LFH
Ah
Cg
R.HG
0
LFH
Ah
Bg
Cg
O.HG
0
LFH
Ae
Bg
Cg
O.G
0
10
20
40
60
80
100

Figure 118. Diagrammatic horizon pattern of some subgroups of the Gleysolic order. (after Anon. 1978c)

1.) Coastal Western Hemlock Biogeoclimatic Zone (CWHg):

- Orthic Gleysols (O.G)

Landform/
Parent Material = colluvial and morainal blankets/ veneers; fluvial slope-washed sediment deposits;
Elevational Range = 0 - 600 m;
Slope Position/Range = lower - upper slopes; 0 - 85 %;
Moisture Regime = subhygric - mesic;
Nutrient Regime = oligotrophic - permesotrophic;
Vegetation Assoc. = hemlock - spruce - foamflower - oak fern; Montane hemlock - cypress - oak fern; cedar - hemlock - salal; cedar - cypress scrub; Montane hemlock - cypress - false hellebore - liverwort;

- Orthic Humic Gleysol (O.HG)

Landform/
Parent Material = colluvial and morainal blankets/ veneers; fluvial slope-washed sediment deposits;
Elevational Range = 0 - 600 m;
Slope Position/Range = lower - middle slopes; 6 -85 %
Moisture Regime = subhygric - hygric;
Nutrient Regime = mesotrophic - permesotrophic;
Vegetation Assoc. = hemlock - spruce - foamflower - oak fern; Montane hemlock - cypress - false hellebore - liverwort;

- Fera Gleysols (FE.G)

Landform/
Parent Material = morainal veneers and blankets;
Elevational Range = 0 - 600 m;
Slope Position/Range = lower - middle slopes; 0 - 30 %;
Moisture Regime = hygric - mesic;
Nutrient Regime = oligotrophic - submesotrophic;
Vegetation Assoc. = cedar - hemlock - salal; cedar - cypress scrub; **cedar - skunk cabbage swamps;**

- Rego Humic Gleysol (R.HG)

Landform/
Parent Material = fluvial veneers/blankets, fans, morainal veneers/blankets;
Elevational Range = 0 - 350 m;
Slope Position/Range = level - toes of slopes - depressions; 0 - 5 %;
Moisture Regime = hygric - subhydric;
Nutrient Regime = submesotrophic - permesotrophic;
Vegetation Assoc. = cedar - skunk cabbage swamps;

2.) Coastal Cedar - Pine - Hemlock Biogeoclimatic Zone (CCPH):

- Orthic Humic Gleysol (O.HG)

Landform/
Parent Material = morainal and colluvial veneers/ blankets; fluvial fans;
Elevational Range = 0 - 600 m;
Slope Position/Range = level - upper slopes; 0 - 40 %;
Moisture Regime = subhygric - hygric;
Nutrient Regime = submesotrophic;
Vegetation Assoc. = cedar - cypress - pine bog forests;

- Rego Gleysol (R.G.)

Landform/
Parent Material = morainal and colluvial veneers/ blankets; fluvial fans;
Elevational Range = 0 - 600 m;
Slope Position/Range = level -slope toes - crests; 0 - 50 %
Moisture Regime = subhygric - hygric;
Nutrient Regime = oligotrophic - submesotrophic;
Vegetation Assoc. = pine - cypress - cedar bog woodland; cedar - cypress - pine bog forests;

- Orthic Gleysol (O.G.)

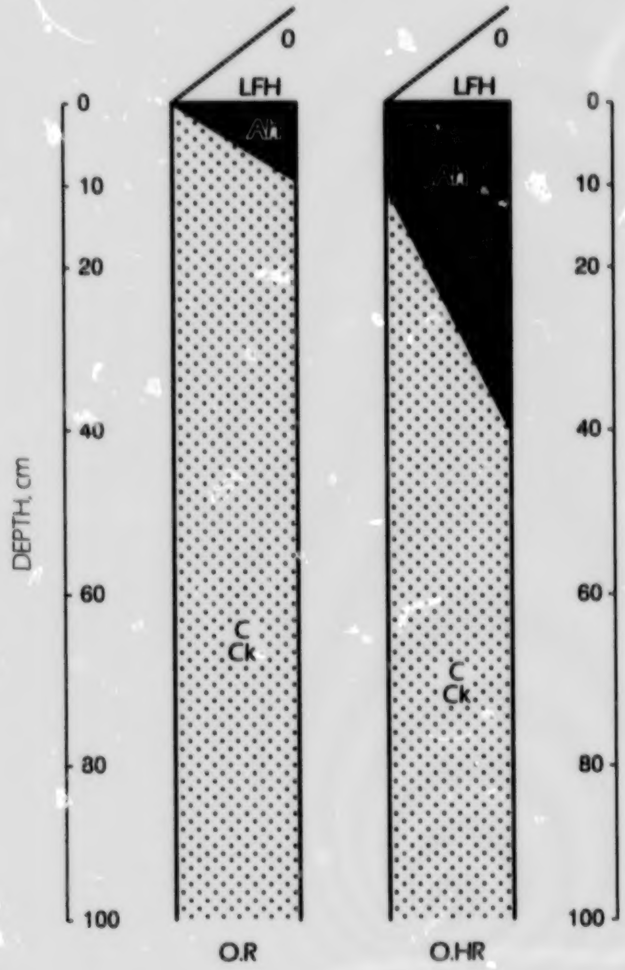
Landform/
Parent Material = colluvial and morainal veneers/ blankets; fluvial blankets/veneers, fans;
Elevational Range = 0 - 600 m;
Slope Position/Range = level - upper slopes, slope toes and depressions; 0 - 60 %;
Moisture Regime = subhygric - subhydric - mesic;
Nutrient Regime = oligotrophic - mesotrophic;
Vegetation Assoc. = zonal cedar - cypress - hemlock - Vaccinium - salal - moss; cedar - cypress - skunk cabbage swamp forest; cedar - cypress - pine bog forests; pine - cypress - cedar bog woodland; pine - cypress open blanket bog;

3.) Mountain Hemlock Zone (MH) & Alpine Tundra Zone (AT)

- No gleysolic soils have been identified to occur in this biogeoclimatic zone.

• THE REGOSOLIC ORDER

Soils of this order are known for their characteristic weak development. They lack genetic horizons due to a variety of factors such as youthfulness, recent alluvial deposition, active geomorphic processes, etc. They may have L, F, and H or O horizons, and sometimes exhibit a weak Ah horizon.



DEPTH, cm
0
10
20
40
60
80
100
O
LFH
Ah
C
Ck
O.R
O
LFH
Ah
C
Ck
O.HR
0
10
20
40
60
80
100

Figure 119. Diagrammatic horizon pattern of some subgroups of the Regosolic order (after Anon. 1978c)

1.) Coastal Western Hemlock Biogeoclimatic Zone (CWHg):

- Orthic Regosol (O.R.)

Landform/
Parent Material = recent fluvial blankets;
Elevational Range = 0 - 350 m;
Slope Position/Range = level; 0 %;
Moisture Regime = mesic - subhygric;
Nutrient Regime = permesotrophic - eutrophic
Vegetation Assoc. = alluvial spruce - grass;

- Gleyed Regosol (Gl.R)

Landform/
Parent Material = colluvial and fluvial fans;
Elevational Range = 0 - 350 m;
Slope Position/Range = slope toes to middle slopes; 25 - 85 %;
Moisture Regime = subhygric - hygric;
Nutrient Regime = permesotrophic;
Vegetation Assoc. = hemlock - spruce - foamflower - oak fern;

- Orthic Humic Regosol (O.HR)

Landform/
Parent Material = sand dunes;
Elevational Range = 0 - 10 m;
Slope Position/Range = level; 0 - 5 %;
Moisture Regime = submesic - mesic;
Nutrient Regime = mesotrophic - permesotrophic;
Vegetation Assoc. = spruce beach/dune forest;

2.) Coastal Cedar - Pine - Hemlock Biogeoclimatic Zone (CCPH):

- Orthic Regosol (O.R.)

Landform/
Parent Material = fluvial blankets and fans;
Elevational Range = 0 - 350 m;
Slope Position/Range = level; 0 - 5 %;
Moisture Regime = mesic;
Nutrient Regime = permesotrophic - eutrophic;
Vegetation Assoc. = alluvial spruce - grass;

3.) Mountain Hemlock Zone (MH) & Alpine Tundra Zone (AT)

- Orthic Humic Regosols are said to occur in these biogeoclimatic zones, but no specific details are available at this time.

• THE ORGANIC ORDER

Soils of this order are for the most part composed of organic materials. They include most of the soils referred to as peat, muck, and bog soils. They are commonly saturated with water for prolonged periods, and contain 17% or more organic C.

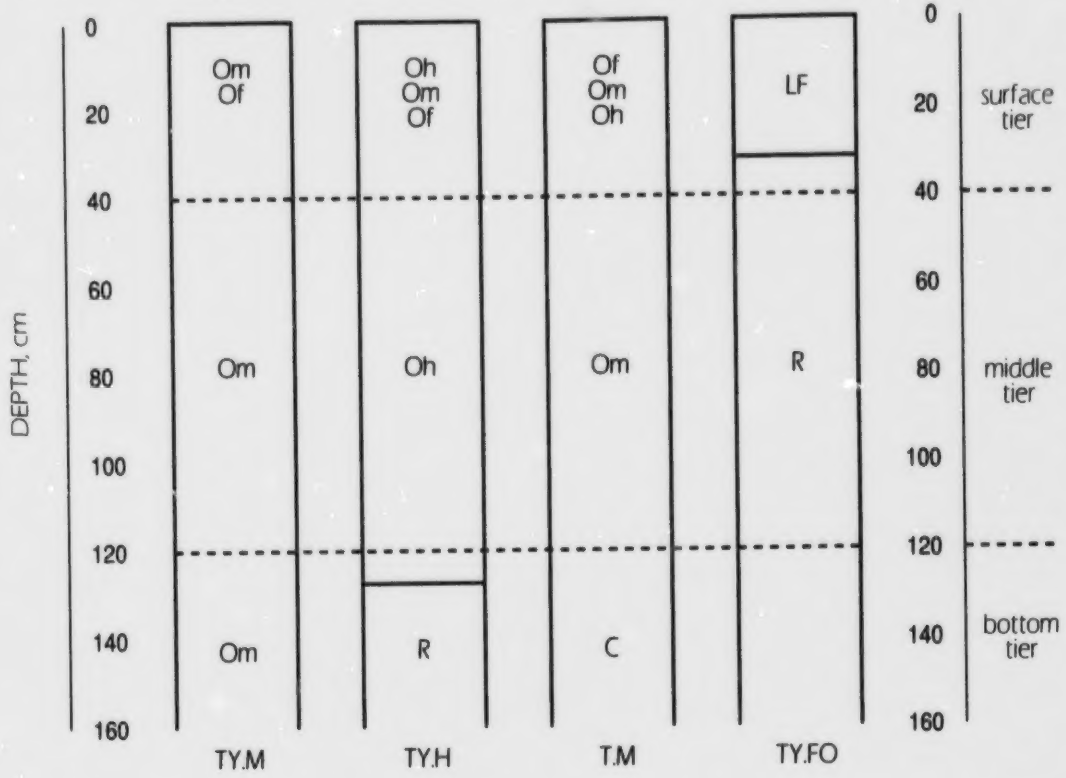

DEPTH, cm
0
20
40
60
80
100
120
140
160
Om
Of
Om
Om
TY.M
Oh
Om
Of
Oh
R
TY.H
Of
Om
Oh
Om
C
T.M
LF
R
TY.FO
surface tier
middle tier
bottom tier

Figure 120. Diagrammatic horizon pattern of some subgroups of the Organic order (after Anon. 1978c)

1.) Coastal Western Hemlock Biogeoclimatic Zone (CWHg):

- Typic Mesisol (TY.M)

Landform/
Parent Material = organic blankets and veneers;
Elevational Range = 0 - 600 m;
Slope Position/Range = lower - middle slopes; 0 - 15 %;
Moisture Regime = hydric - hygric;
Nutrient Regime = oligotrophic - submesotrophic
Vegetation Assoc. = cedar - cypress scrub; cedar - skunk cabbage swamps; topogenous bogs;

- Terric Mesisol (T.M)

Landform/
Parent Material = organic blankets and veneers;
Elevational Range = 0 - 350 m;
Slope Position/Range = level - depressions; 0 - 5 %;
Moisture Regime = subhydric - hydric;
Nutrient Regime = oligotrophic - mesotrophic;
Vegetation Assoc. = cedar - skunk cabbage swamps; topogenous bogs;

- Typic Humisol (TY.H)

Landform/
Parent Material = organic veneers and blankets;
Elevational Range = 0 - 350 m;
Slope Position/Range = depressions; level - slope toes; 0 - 5 %;
Moisture Regime = hygric - subhydric;
Nutrient Regime = submesotrophic - mesotrophic;
Vegetation Assoc. = cedar - skunk cabbage swamps;

- Terric Humisol (T.H)

Landform/
Parent Material = organic veneers and blankets;
Elevational Range = 0 - 350 m;
Slope Position/Range = depressions; level - slope toes; 0 - 5 %;
Moisture Regime = hygric - subhydric;
Nutrient Regime = submesotrophic - mesotrophic;
Vegetation Assoc. = cedar - skunk cabbage swamps;

1.) Coastal Western Hemlock Biogeoclimatic Zone (CWHg): continued

-Typic Folisol (TY.FO)

Landform/
Parent Material = organic veneer over bedrock; rocky coastal headlands;
Elevational Range = 0 - 600 m;
Slope Position/Range = lower slopes - crests; 0 - 100 %;
Moisture Regime = subhygric - subxeric;
Nutrient Regime = submesotrophic - permesotrophic;
Vegetation Assoc. = dry cedar - salal; spruce - reedgrass seacoast forest; spruce - hemlock - sword fern; zonal hemlock -moss; Montane zonal hemlock moss; hemlock - spruce - foamflower - oak fern; Montane hemlock - cypress - oak fern; cedar - cypress scrub;

2.) Coastal Cedar - Pine - Hemlock Biogeoclimatic Zone (CCPH):

-Typic Mesisol (TY.M)

Landform/
Parent Material = fluvial blankets; organic and saprolitic veneers/blankets;
Elevational Range = 0 - 600 m;
Slope Position/Range = depressions; level - slope toes - crests; 0 - 60 %;
Moisture Regime = sughygric - subhydric;
Nutrient Regime = oligotrophic - mesotrophic;
Vegetation Assoc. = cedar - cypress skunk cabbage swamp forest; cedar - cypress pine bog forest; pine - cypress cedar bog woodland; pine - cypress open blanket bogs; topogenous Sphagnum bogs;

- Typic Fibrisol (TY.F)

Landform/
Parent Material = organic, morainal, and saprolitic veneers;
Elevational Range = 0 - 600 m;
Slope Position/Range = level - upper slopes; 0 - 60 %;
Moisture Regime = subhydric - hydric;
Nutrient Regime = oligotrophic;
Vegetation Assoc. = pine - cypress open blanket bogs;

2.) Coastal Cedar - Pine - Hemlock Biogeoclimatic Zone (CCPH): continued

- Typic Folisol (TY.FO)

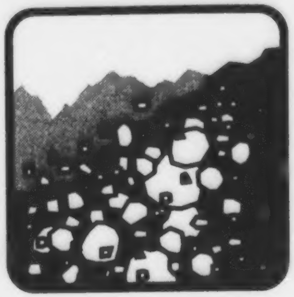
Landform/ Parent Material = organic veneers over bedrock; rocky coastal headlands;
Elevational Range = 0 - 600 m;
Slope Position/Range = middle slopes - crests; rarely lower slopes; 0 - 100 %;
Moisture Regime = subxeric - subhygric;
Nutrient Regime = oligotrophic - permesotrophic;
Vegetation Assoc. = dry shore pine - juniper - lichen; submesic cedar - cypress - hemlock - shore pine - salal - moss; spruce - salal - reed grass seacoast forest; hemlock - cedar - Vaccinium - deer fern - moss; zonal cedar - cypress - hemlock - Vaccinium - salal - moss; hemlock - cedar - spruce - foamflower - oak fern - ladyfern; cedar - cypress - pine bog forest; pine - cypress cedar bog woodland;

3.) Mountain Hemlock Zone (MH) & Alpine Tundra Zone (AT)

- Typic Folisols are said to occur in these biogeoclimatic zones, but no specific details are available at this time.

Beyond the soil information provided thus far, there are no known works that provide a full description of the landforms, genetic materials, calcareousness, textural groups, and similar physical soil characteristics required for land management purposes. However, Klinka et al. (1981) described a complex taxonomic classification scheme for the humus forms in British Columbia. The description, discussion, and application of that classification to the South Moresby/Gwaii Haanas National Park Reserve will have to wait until the soil resources within the reserve have been studied and described to greater detail than they are at the present.

The situation is somewhat different with the soil-related mass wastage problems caused by avalanches, slope failures, debris slides, flows and torrents generated by seismic and geomorphic processes on the steep slopes throughout the Islands. The regional mass wasting inventory recently presented by Gimbarzevsky (1988) indicates a strong correlation of landslide intensity with topographic, physiographic, and climatic characteristics of the landscape. The author established that a total of 8328 active mass wasting sites occurred within the 2553 sq. km of active segments of drainage basins. 75 percent of the area affected by slope failures was in the "moderate" class (= 1-3 failures per sq. km), 23 percent was in the "severe" class (= 4 - 7 failures per sq. km), while 2 percent fell within the "extreme" class (= >8 failures per sq. km). The mean slope failure frequency was 3.26 failures per square kilometre for the active areas of drainage basins. The mass wasting inventory by Gimbarzevsky (1988) included the area contained in the South Moresby/Gwaii Haanas National Park Reserve, and all of the active sites identified there were mapped according to their assigned severity classes.



The soils and forests of the Coast Forest Region in North America extend over about 129,450 square kilometres from the State of Washington to Alaska, and includes the Canadian section from the 49th parallel to the Queen Charlotte Islands. Most of the soils are known for their high productivity which supports a dense coniferous forest of tall growth (Clayton et al. 1977); however, the areas with organic soils on the Queen Charlotte Islands are nonproductive for forest growth. The biomass productivity of these soils is considered to be the highest in Canada; i.e., *usually greater than* $7m^{3ha.}$ *and in some areas exceeding* $14\ m^{3/ha}$. *It is only along the exposed outer coast, as for example the west coast of the Queen Charlotte Islands, that the gale force winds off the Pacific Ocean do impose a limiting effect on the biomass productivity of the soils.*

As far as the broad geographic extent, productivity, and utilization of the local soil orders are concerned (Clayton et al. 1977):

- *The Podzols are the dominant soil order in 22.5 percent of the Canadian land area, where they occur under a variety of climatic regimes; on the Islands, as elsewhere, their parent materials are dominantly acidic, and have developed most commonly on coarse-textured till and glaciofluvial deposits with an undulating to mountainous topography; no significant agricultural acreages have been developed on podzolic soils in western Canada, due in part that this soil order requires annual applications of nitrogen, phosphorus and potassium in order to remain productive; their vulnerability to water erosional processes on especially mountainous terrain is of a large concern.*

- *The Brunisols are the dominant soil order in 10.5 percent of this country, where mostof them occur under humid and perhumid moisture conditions; in the Queen Charlotte Islands, the representative sub-groups developed on both basic and acidic parent materials overlain by medium to coarse-textured till and fluvial deposits occupying for 80 percent of their presence, rolling and mountainous terrain; forest biomass and agricultural productivity is generally good and fertility limitations are only slight to moderate, depending on the presence of suitable textures and topography; the inherent erosion potential, stonyness, and saturated conditions on steep slopes can be the cause of some concern.*

- *The poorly drained Gleysols are believed to be the dominant soil order over about 5.4 percent of the country's land mass, where most of them occur under aquic to subaquic moisture conditions; they occur on the Islands on a wide variety of parent materials from till to alluvial deposits and even on those of lacustrine and marine origins; they usually occupy lower slope positions, depressions and undulating to rolling terrains; their productivity is usually low and restricted to hydrophytic and forest-marsh vegetations, but in some exceptional locales and under conditions of controlled drainage, agricultural productivity may range from fair to moderate; where these soils have developed on acidic parent materials and have low base saturation their mineral nutrient fertility limitations are high;*

- *The Regosols are the dominant soil order over roughly 25 percent of Canada's land area; most of them occur on the Islands under a variety of soil moisture conditions, parent materials, and terrains; the shallow nature and weak profiles of these soils in combination with the usually active geomorphic processes under which they exist, limits their biomass productivity and utility to human use.*

- *The Organic soils comprise about 10 percent of Canada's land area, and are subdominant associates within other soil group landscapes where they occupy the poorly drained sections; they are a complex order that occurs under the peraquic and subaquic sub-classes of all temperature regimes and are usually associated with the better drained soils of perhumid, humid, and subhumid moisture regimes; under natural conditions, their primary utility is that of providing wildlife habitats, and unless their water-holding capacity is controlled, their biomass productivity is otherwise low.*

- Management Concerns

The primary soil management concern for the South Moresby/Gwaii Haanas National Park Reserve is that developmental and recreational activities,which might be initiated on the basis of the current socio-political climate and local expectations, may be forced upon the soilscapes before their full capabilities and limitations have been sufficiently studied and reported upon, so as to allow park- and resource managers to build proper safeguards into the decision-making processes.

- Status of Knowledge

The present status of knowledge concerning the pedology of the South Moresby/Gwaii Haanas National Park Reserve is without a doubt inadequate to provide for well-informed, site- or area-specific facility development decisions to be made, without running the risk of making irreparable judgemental errors with a potential for long-term environmental and aesthetic impairment.

b) SELECT REFERENCE SOURCES

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B. MARINE SOIL RESOURCES

Marine soils as such do not exist, but it is possible to address the subject of surficial geology as a counterpart to terrestrial soils, distinguishing sedimentology from the remainder of marine geology by its more rapid dynamism. The distinction is, admittedly, an artificial one. After all, the second oldest rock unit of the area, the Kunga Formation, owes its origin to sedimentological processes as it is itself a flysh deposit, laid down in a marine basin which initially contained no terrigenous matter and was possibly relatively shallow (Brown 1968).

In the scale of sedimentary provinces of the north Pacific Ocean, the northeast Pacific is a third-order province (King 1975). The first-order provinces are distinguished by a lack of terrigenous sediments due to the presence of bordering trenches along the greater part of the Pacific margin. The second-order provinces are notable for their positive relief features. The third-order provinces are a narrow zone of terrigenous sediments around the perimeter of the north Pacific, as well as the turbidite province of the northeast Pacific basin.

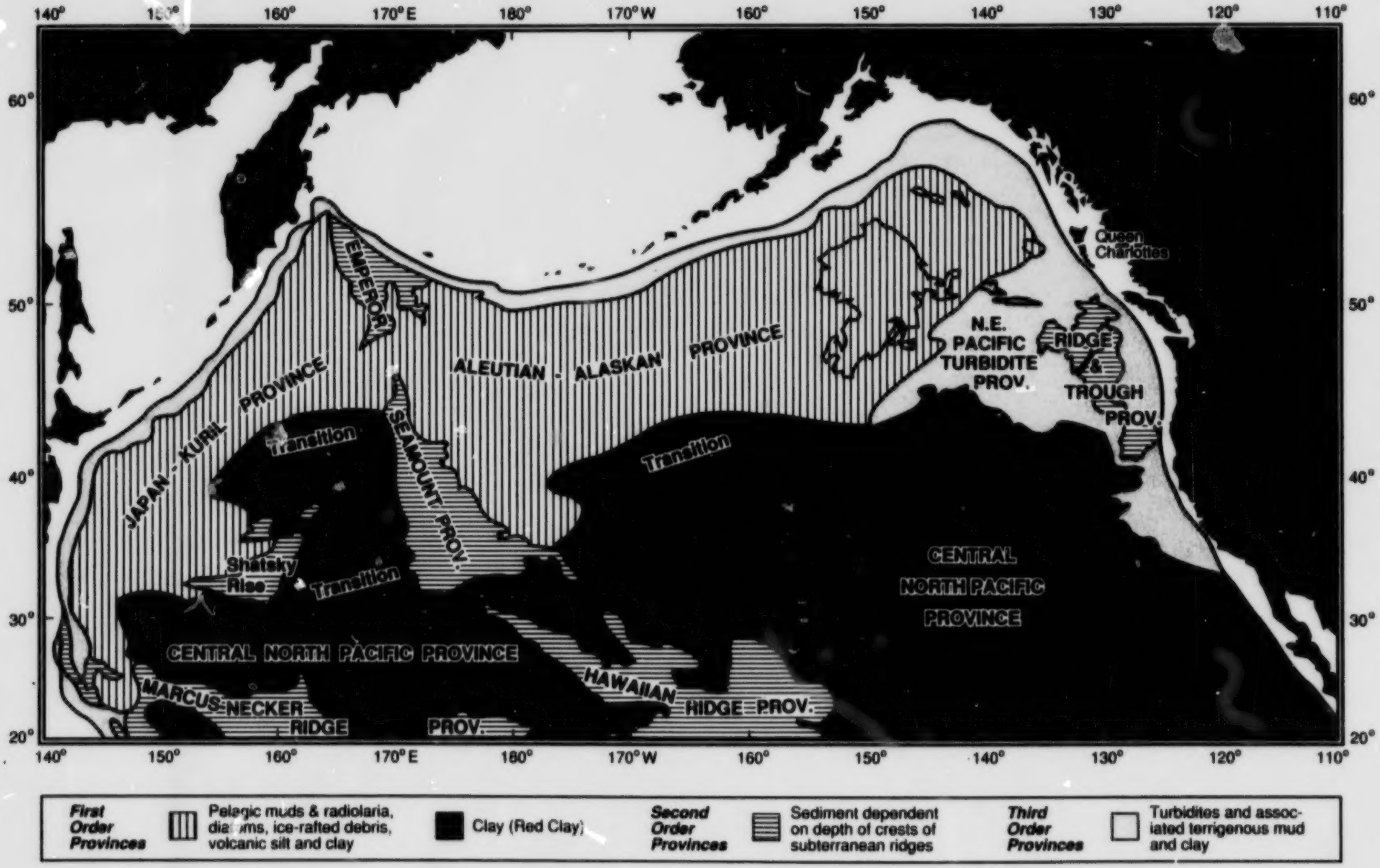
140°
150°
160°
170° E
180°
170° W
160°
150°
140°
130°
120°
110°
60°
50°
40°
30°
20°
Queen Charlottes
EMPEROR
SEAMOUNT PROV.
JAPAN - KURIL PROVINCE
ALEUTIAN - ALASKAN PROVINCE
N.E. PACIFIC TURBIDITE PROV.
RIDGE & TROUGH PROV.
Transition
Shatsky Rise
Transition
Transition
CENTRAL NORTH PACIFIC PROVINCE
CENTRAL NORTH PACIFIC PROVINCE
MARCUS-NECKER RIDGE PROV.
HAWAIIAN RIDGE PROV.
First Order Provinces
Pelagic muds & radiolaria, diatoms, ice-rafted debris, volcanic silt and clay
Clay (Red Clay)
Second Order Provinces
Sediment dependent on depth of crests of subterranean ridges
Third Order Provinces
Turbidites and associated terrigenous mud and clay

Figure 121. Sedimentary provinces in the north Pacific Ocean (after Horn, Horn & Delach 1970)

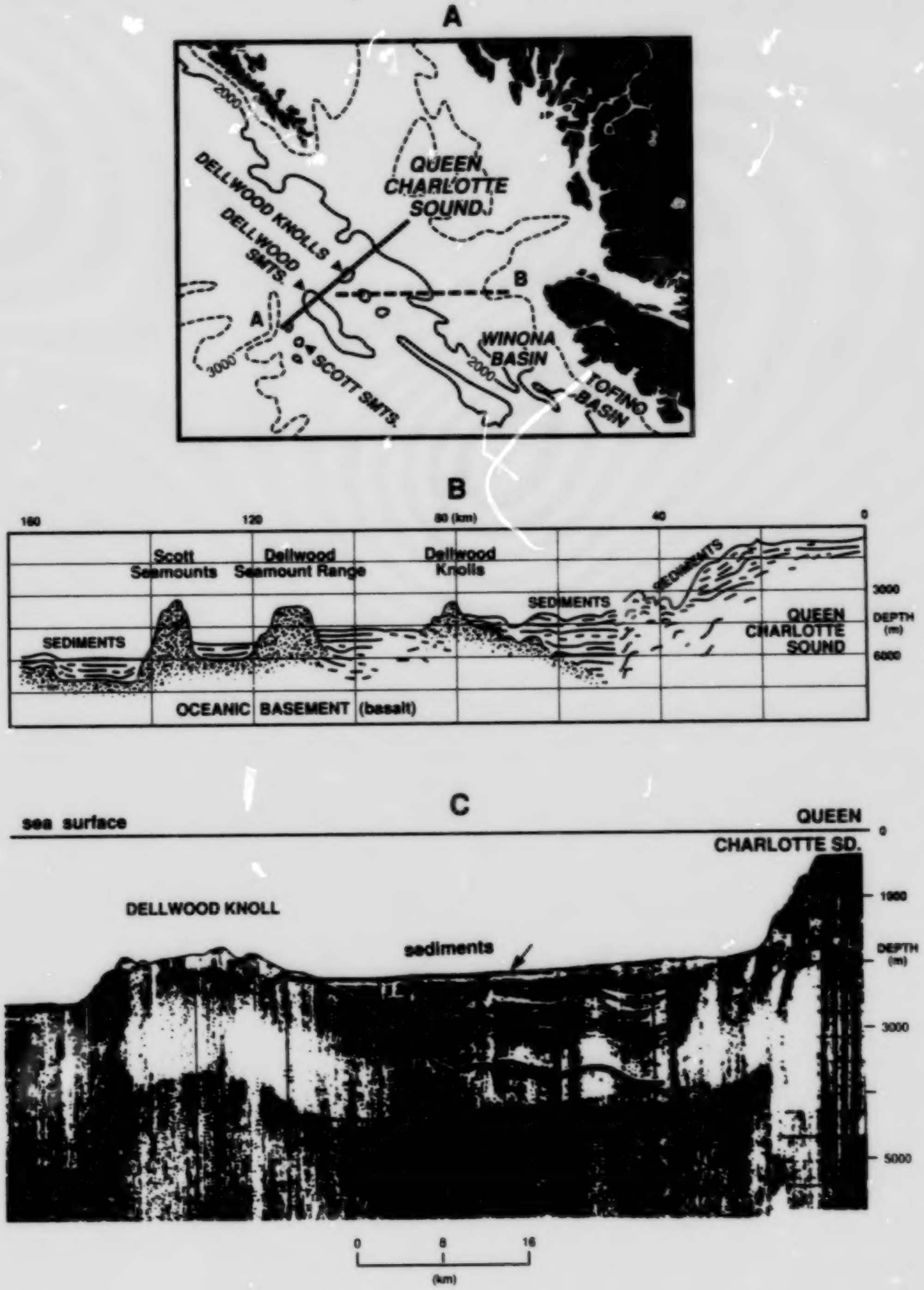
A
QUEEN CHARLOTTE SOUND
DELLWOOD KNOLLS
DELLWOOD SMTS.
SCOTT SMTS.
WINONA BASIN
TOFINO BASIN
A
B
2000
3000
B
160
120
80 (km)
40
0
Scott Seamounts
Dellwood Seamount Range
Dellwood Knolls
SEDIMENTS
SEDIMENTS
SEDIMENTS
QUEEN CHARLOTTE SOUND
3000
DEPTH (m)
6000
OCEANIC BASEMENT (basalt)
C
sea surface
QUEEN CHARLOTTE SD.
0
1000
DEPTH (m)
3000
5000
DELLWOOD KNOLL
sediments
0
8
16
(km)

Figure 122. A) Seismic lines taken over northern continental margin seaward from Queen Charlotte Sd. B) Seismic lines 'A'-seaward dipping sediments under the continental shelf, and damming of sediment by the Dellwood knolls and Seamount Ranges. C) Seismic line 'B'-deep sediments of Winona Basin at the base of the slope. Thick, solid line indicates the probable depth of the basement rock beneath these sediments (after Thomson 1981)

The narrow Continental shelf and precipitous Continental slope off the Queen Charlotte Islands have enabled the down-slope movement of sediments derived from the erosion of the adjacent land (Thomson 1981). Where the shelf does widen out south of the Queen Charlotte Islands, it acts as a sediment trap, broken only by cuts like the Moresby Channel and the Scott Channel which are the result of fracturing faults in the earth's crust or glacial action dating from a time of much lower sea levels. Such cuts serve not only as submarine stream channels for the flow of heavier, colder water, but as debris channels for downward sediment transport.

To the east of the Queen Charlotte Islands, the whole of the Queen Charlotte Basin lies beneath Hecate Strait and Queen Charlotte Sound except for the northwestern corner which is exposed as the Argonaut Plain on Graham Island. The basin is reportedly filled with non-marine sediments of Pliocene age from 0.8 kilometres (Tiffin 1973) to 2 kilometres (Shouldice 1971) in depth which probably rest without conformity on from 2.3 kilometres (Tiffin 1973) to 3 kilometres (Shouldice 1971) of non-marine sediments of Upper Miocene age. The whole is underlain by marine and volcanic rocks of Mesozoic and pre-Mesozoic age (Shouldice 1971). On the shallow banks of Hecate Strait, sand and gravel predominate over fine materials (Westrheim *et al.* 1980a,b). Apparently, gravel dominates off Moresby Island, though sand dominates in the area south of Rose Spit. Even in the northerly parts of the Hecate Strait, sand dominates over mud. The sands of the basin are composed primarily of feldspar and quartz, high in porosity and low in permeability.

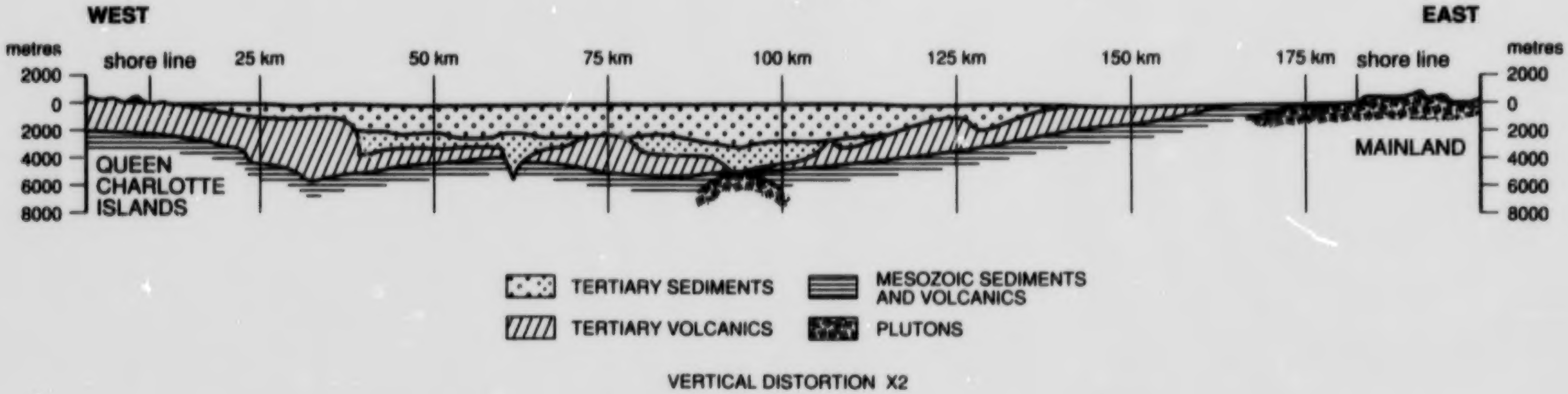
WEST
EAST
metres
2000
0
2000
4000
6000
8000
shore line
25 km
50 km
75 km
100 km
125 km
150 km
175 km
shore line
metres
2000
0
2000
4000
6000
8000
QUEEN CHARLOTTE ISLANDS
MAINLAND
TERTIARY SEDIMENTS
TERTIARY VOLCANICS
MESOZOIC SEDIMENTS AND VOLCANICS
PLUTONS
VERTICAL DISTORTION X2

Figure 123. Cross section illustrating regional stratigraphic relationships in the Queen Charlotte Basin (after Shouldice 1971)

The occurrence of extensive gravel deposits has been documented in Dixon Entrance by Mathews (1958) and Harper (1980a, 1980b). Some of the coarse material amongst the sand, gravel and boulders deposited just north of Graham Island may be a lag deposit, the finer glacial debris having been washed out either at the time of glaciation or more recently. The wide, long beach plain which continues to develop on the northeast coast of Graham Island (McIntyre Bay) is unique to British Columbia in that it combines a wide, sandy beach, extensive dunes and a prograding shoreline, the source of which is apparently offshore.

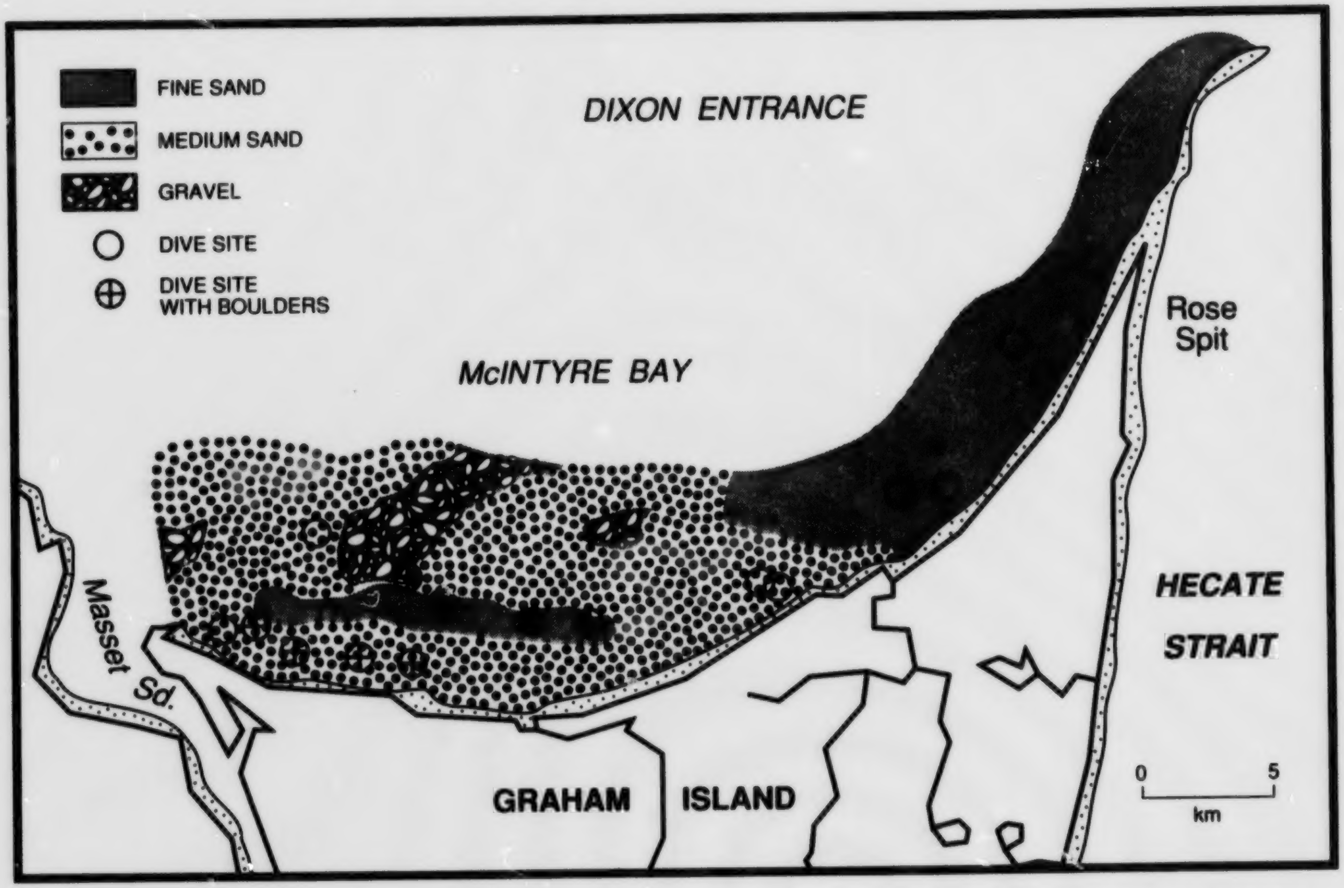
FINE SAND
MEDIUM SAND
GRAVEL
DIVE SITE
DIVE SITE WITH BOULDERS
DIXON ENTRANCE
McINTYRE BAY
Rose Spit
HECATE STRAIT
Masset Sd.
GRAHAM ISLAND
0
5
km

Figure 124. Surficial sediment distribution, McIntyre Bay, north coast of Graham Island (after Anon. 1980a)

Both the coast of the Queen Charlotte Islands and the coast of the adjacent British Columbia mainland are crenulated with fjords and channels. Within the shelter of those marine environments, surficial sediments appear to consist mostly of mud or mud and sand (Sharma 1979). Gravels and sands are also present at the mouths of streams and rivers. Slump and landslide deposits from the walls and heads of channels contribute to the surficial sediments as well (Bornhold 1983, Bornhold & Prior 1981, Carlson 1978, Luternauer & Swan 1978, Prior *et al.* 1982). Carbonate sedimentation may be greater than clastic deposition in the case of streams with a low sediment load (Hoskin & Nelson 1969).

It is in the shore zone that the marine surficial geology is most easily witnessed, and there too, that it has the greatest impact on human activity. On the outer coast, a steep, rocky shoreline and high wave energy levels result in a rocky shore with little sediment accumulation (Anon. 1983). What few beaches do exist are often composed of a mixture of coarse sediments and rock which remain only by virtue of the shelter provided by inlets and barrier islands. The sediments themselves are locally derived, transport being restricted due to bedrock control. The somewhat more protected shoreline of Dixon Entrance presents a lower relief than that of the outer shores, and beaches are more common. On Graham Island, west of Masset Inlet, there are a number of mixed-sediment, pocket beaches the sediment source for which is generally surface runoff. East of Masset, in McIntyre Bay, the source for the uniquely long, wide, prograding beaches, backed by an extensive dune system, appears to a be offshore, glacial sediment (Harper 1980a). The even more sheltered east coast of Graham Island boasts extensive sand, gravel and cobble beaches, the source for which are the high cliffs behind them. Along the semi-exposed east coast of Moresby Island, sand is not as abundant. There, beaches are comprised mostly of cobbles and boulders. The generally steep, rocky shoreline on the mainland side of Hecate Strait generally prevents the accumulation of sediments much as the outer coast does.

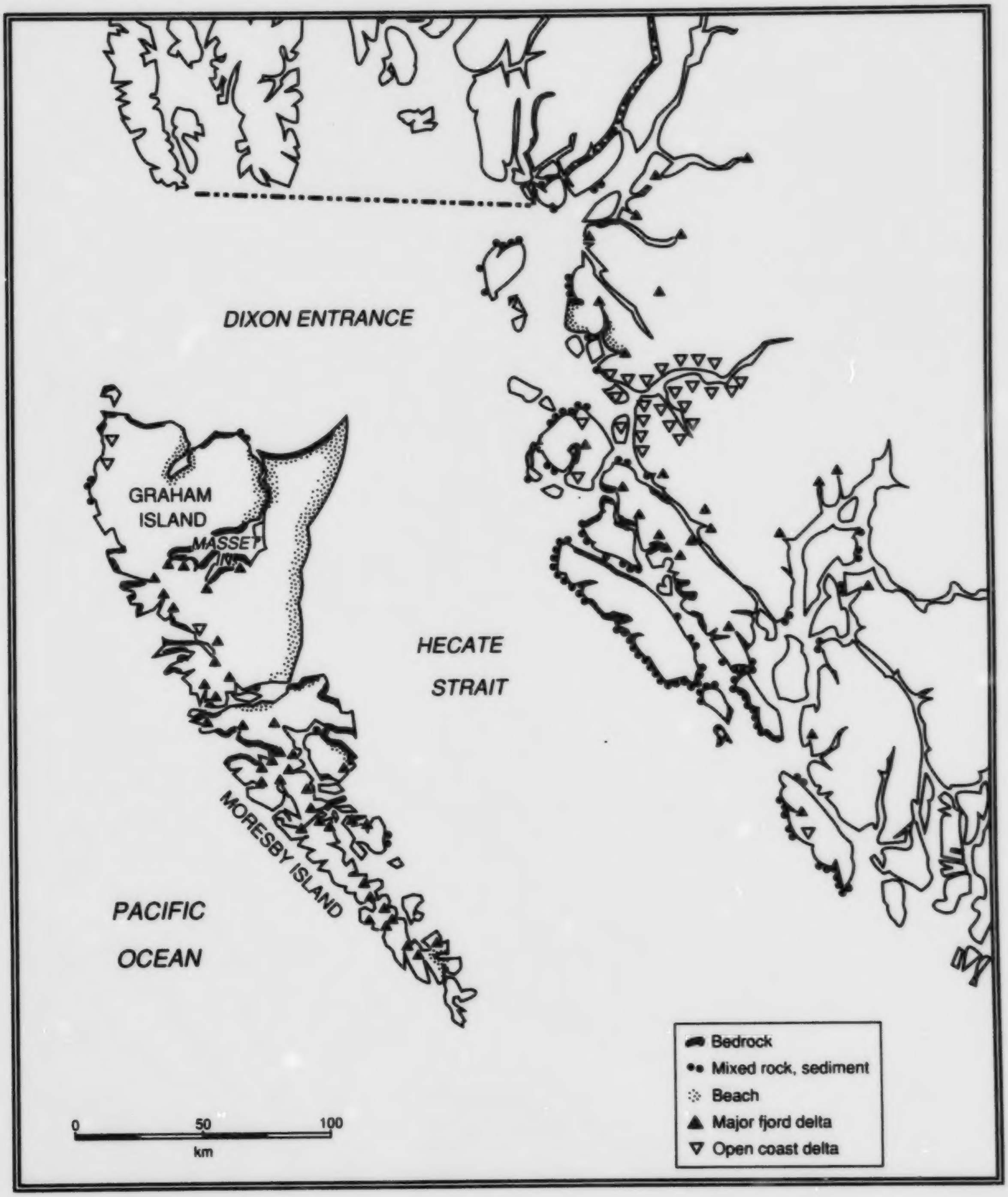
DIXON ENTRANCE
GRAHAM ISLAND
MASSET INLET
HECATE STRAIT
MORESBY ISLAND
PACIFIC OCEAN
0
50
100
km
Bedrock
Mixed rock, sediment
Beach
Major fjord delta
Open coast delta

Figure 125. Physical shore-zone characteristics in northwestern British Columbia. (after Claque & Bornhold)

a) RESOURCE ANALYSIS

The rock formation which makes up a large part of the ocean floor in the area of the Queen Charlotte Islands, the Kunga Formation is, itself, a flysh deposit. But the sediment which warrants contemporary attention is that composed of the overlying and younger deposits which are subject to transport and deposition. It is the dynamic nature of those deposits which makes them important. As is the case with any other dynamic resource, a spatially or temporally sporadic inventory thereof is of little value to those wishing to understand and manage the resource.

While the steep Continental slope offshore from the narrow Continental shelf makes for swift down-slope movement of sediments eroded from the Queen Charlotte Islands themselves, that movement is predictable. It is not possible to anticipate with the same certainty the transport and deposition of the gravels, sands and finer particles of the more sheltered Dixon Entrance, Hecate Strait and Queen Charlotte Sound Regions. The shallower and more protected environment of those coastal waters renders sediments far more subject to the vagaries of wind, waves, currents, and freshwater outflows.

- Management Concerns

Sediment instability represents a geotechnical hazard capable of generating a small Tsunami such as the one experienced in Kitimat Arm in April of 1975. For safety's sake alone, the surficial geology of the marine component of South Moresby/Gwaii Haanas National Park Reserve wants mapping and analysis.

The most difficult part of managing a dynamic resource such as marine sediments is the matter of having studies keep up with the changes. The inventory of the resource must be as active as the resource itself. The nature of sediment composition has consequences for activities such as channel dredging and the placement of piers. Likewise, the dredging of channels, building of piers, extraction and infilling, have consequences for the dynamics of the sediment regime itself which warrant careful monitoring. The high incidence of mass wasting on the Queen Charlotte Islands as a result of improper roadbuilding and clearcut logging on steep slopes is a well-documented (Gimbarzewsky 1988) contributing factor to the changing nature of coastal sedimentology.

- Status of Knowledge

Through no fault of the researchers, reports on the surficial geology of the marine environment surrounding the Queen Charlotte Islands is peppered with words such as conceivably, apparently, and probably. They freely admit that our current knowledge is limited both in its temporal scope and its substance. The few studies done in the area range over more than 20 years and do not cover the marine component of the national park reserve.

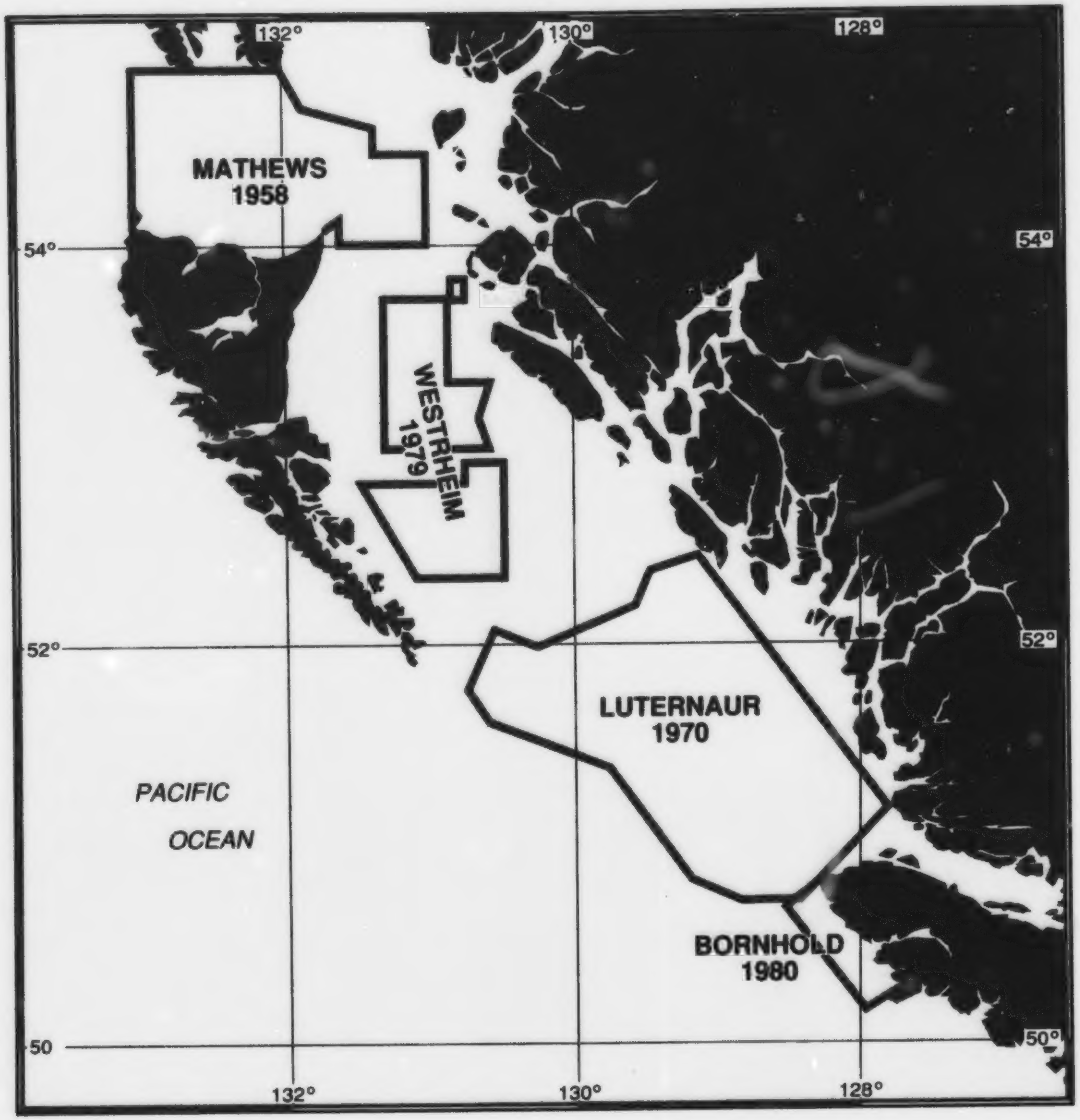
132°
130°
128°
54°
52°
50
54°
52°
50°
132°
130°
128°
MATHEWS
1958
WESTRHEIM
1979
LUTERNAUR
1970
BORNHOLD
1980
PACIFIC
OCEAN

Figure 126. Areas of studies on surficial sediments (after Bornhold 1981)

b) SELECT REFERENCE SOURCES

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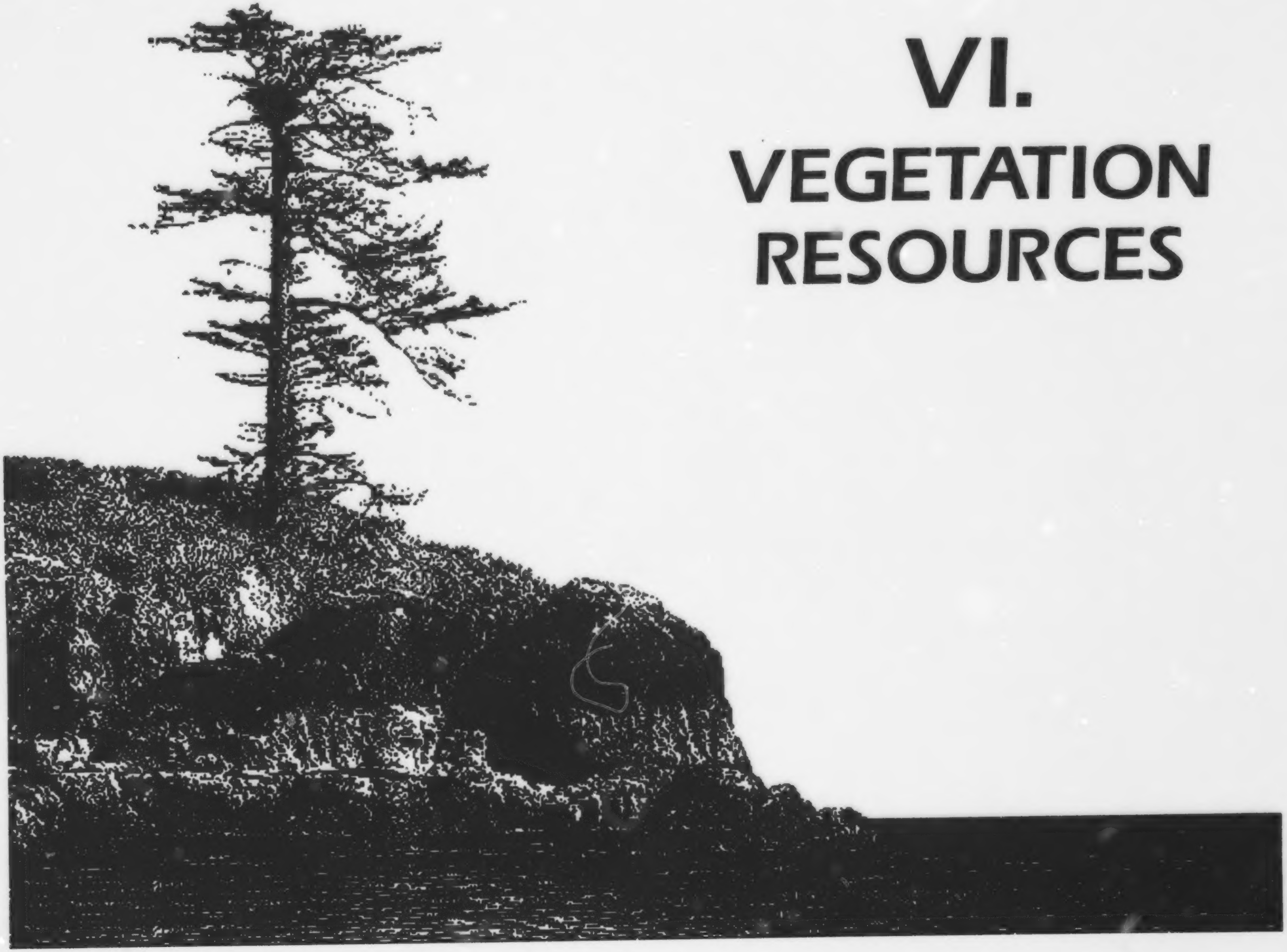
Geology of the Western Canadian Continental Shelf. Bull. of Can. Pet. Geology 19: 405-436.

VI.

VEGETATION RESOURCES



VEGETATION RESOURCES

GENERAL OVERVIEW

The presence and distribution of the earth's vegetation is the result of a very long process of development influenced by past and present environmental factors. In addition, the movement of the tectonic crustal plates in relation to one another and to the earth's poles has caused floristic development to undergo repeated changes over time, often along divergent routes. These differences have led to the classification of the earth's vegetation into a number of "floristic realms", otherwise referred to as major biogeographical divisions. Thus, the Queen Charlotte Islands are now recognized to be situated within the *Holarctic Realm* (Walter 1973), as is the remainder of the northern hemisphere.

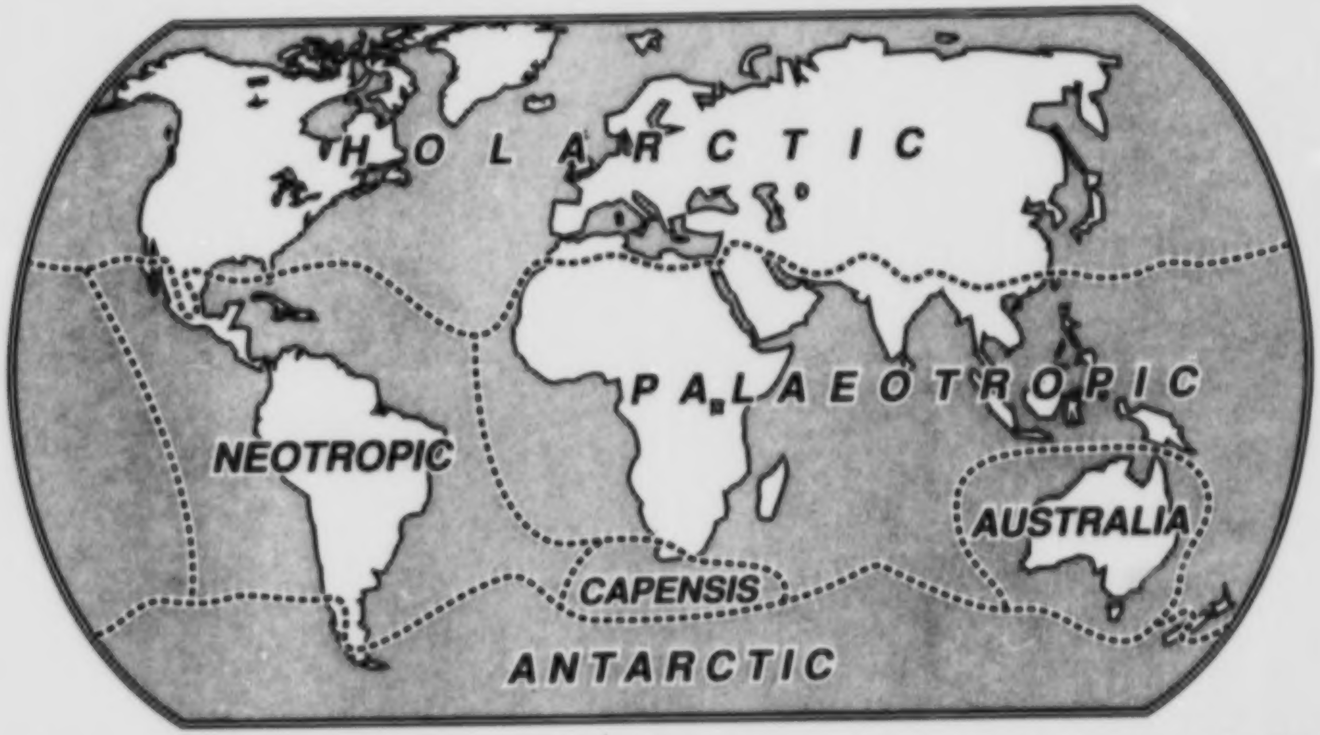
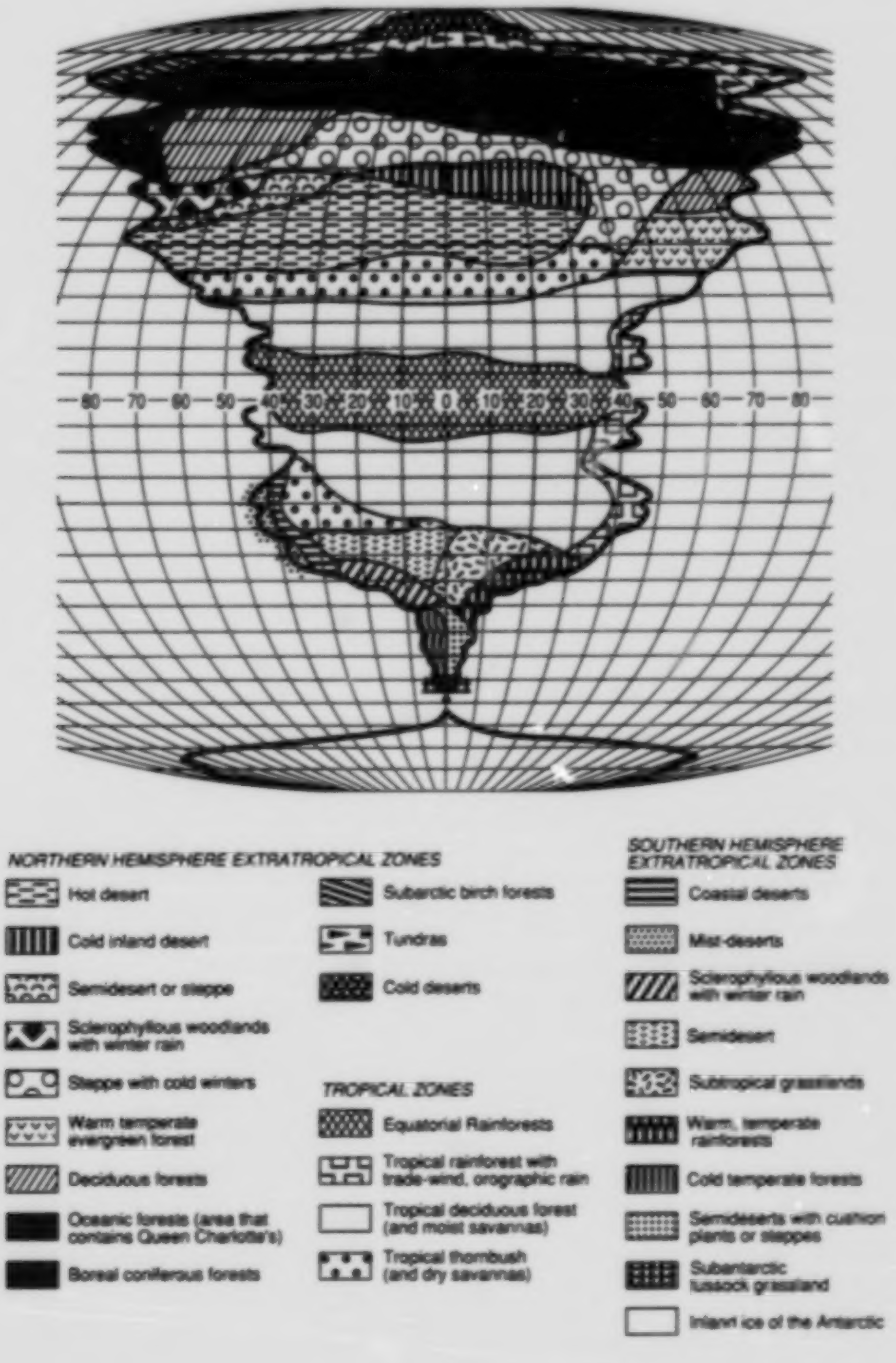


Figure 127. Floristic realms. In New Zealand, Antarctic as well as Paleotropic and Australian elements occur (after Walter 1973)



80
70
60
50
40
30
20
10
0
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20
30
40
50
60
70
80
NORTHERN HEMISPHERE EXTRATROPICAL ZONES
Hot desert
Cold inland desert
Semidesert or steppe
Sclerophyllous woodlands with winter rain
Steppe with cold winters
Warm temperate evergreen forest
Deciduous forests
Oceanic forests (area that contains Queen Charlotte's)
Boreal coniferous forests
Subarctic birch forests
Tundras
Cold deserts
TROPICAL ZONES
Equatorial Rainforests
Tropical rainforest with trade-wind, orographic rain
Tropical deciduous forest (and moist savannas)
Tropical thornbush (and dry savannas)
SOUTHERN HEMISPHERE EXTRATROPICAL ZONES
Coastal deserts
Mist-deserts
Sclerophyllous woodlands with winter rain
Semidesert
Subtropical grasslands
Warm, temperate rainforests
Cold temperate forests
Semideserts with cushion plants or steppes
Subantarctic tussock grassland
Inland ice of the Antarctic

Figure 128. 'Average continent' showing the asymmetry in vegetational zones in the Northern and Southern Hemispheres (after Walter 1973)

Walter (1973), furthermore, considered it essential to the understanding of the earth's vegetation that it be arranged into "zonal" vegetations based on individual climatic regimes. He noted that the northern and southern hemispheres were asymmetric in terms of their broad vegetation zone s, especially with reference to the zone of "Oceanic Forests" which, conceptually at least, contains the type of forest vegetation found on the Queen Charlotte Islands.

Other ecologists (Odum 1971; Shelford 1963) described the same vegetation zonations in a North American and "biomal" context (= ecological subdivision usually based on the characteristic vegetation) which places the Queen Charlotte Islands firmly into the *"Moist Coniferous Forest/Northern Pacific Coast Rainy Western Hemlock Forest Biome"*. That biome roughly conforms to the coastline and inlets of the northwestern Pacific Ocean from about mid-California to southern Alaska. It attains an average width of 320 kilometres and extends over a length of 3680 kilometres, while its highest elevations drop from about 1500 metres in the State of Oregon, to 600 metres in the State of Alaska. Its generalized forest types range from western hemlock-cedar forests on the western slopes of the Cascades and coast ranges, to redwood forests on various slopes and pockets near the coast of the States of Oregon and California, and the hemlock-spruce forests found on Kodiak Island in the State of Alaska.

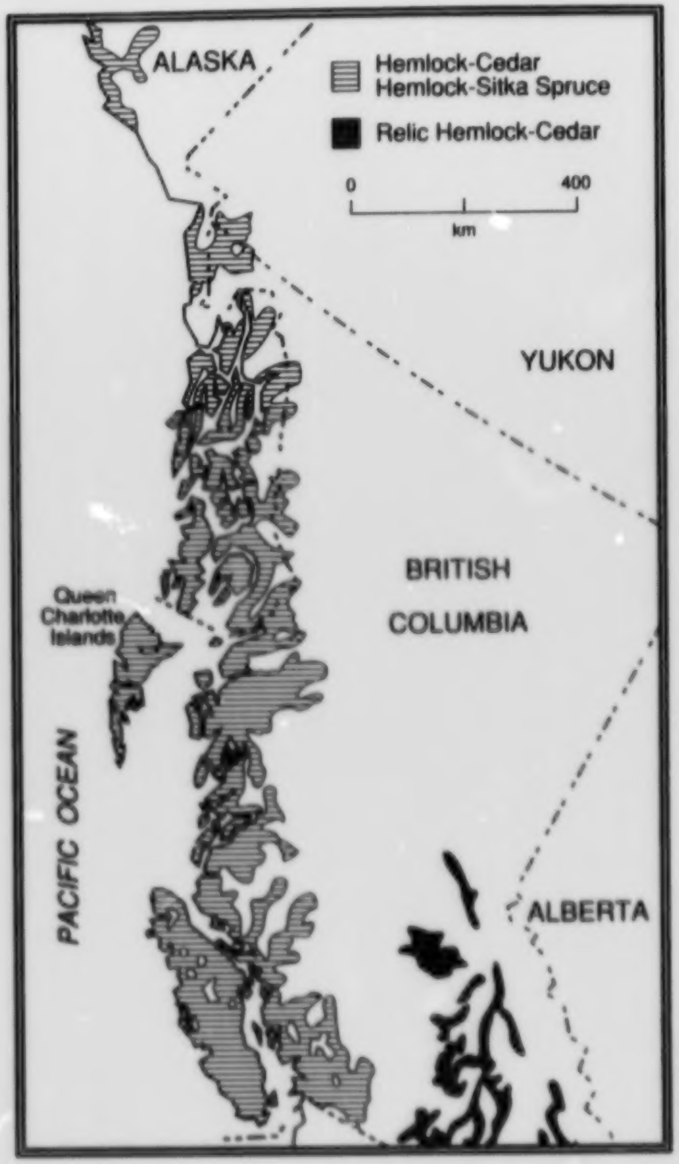

Figure 129. Distribution of the Hemlock-Cedar, Hemlock-Sitka Spruce and the relic Hemlock-Cedar (after Shelford 1963)

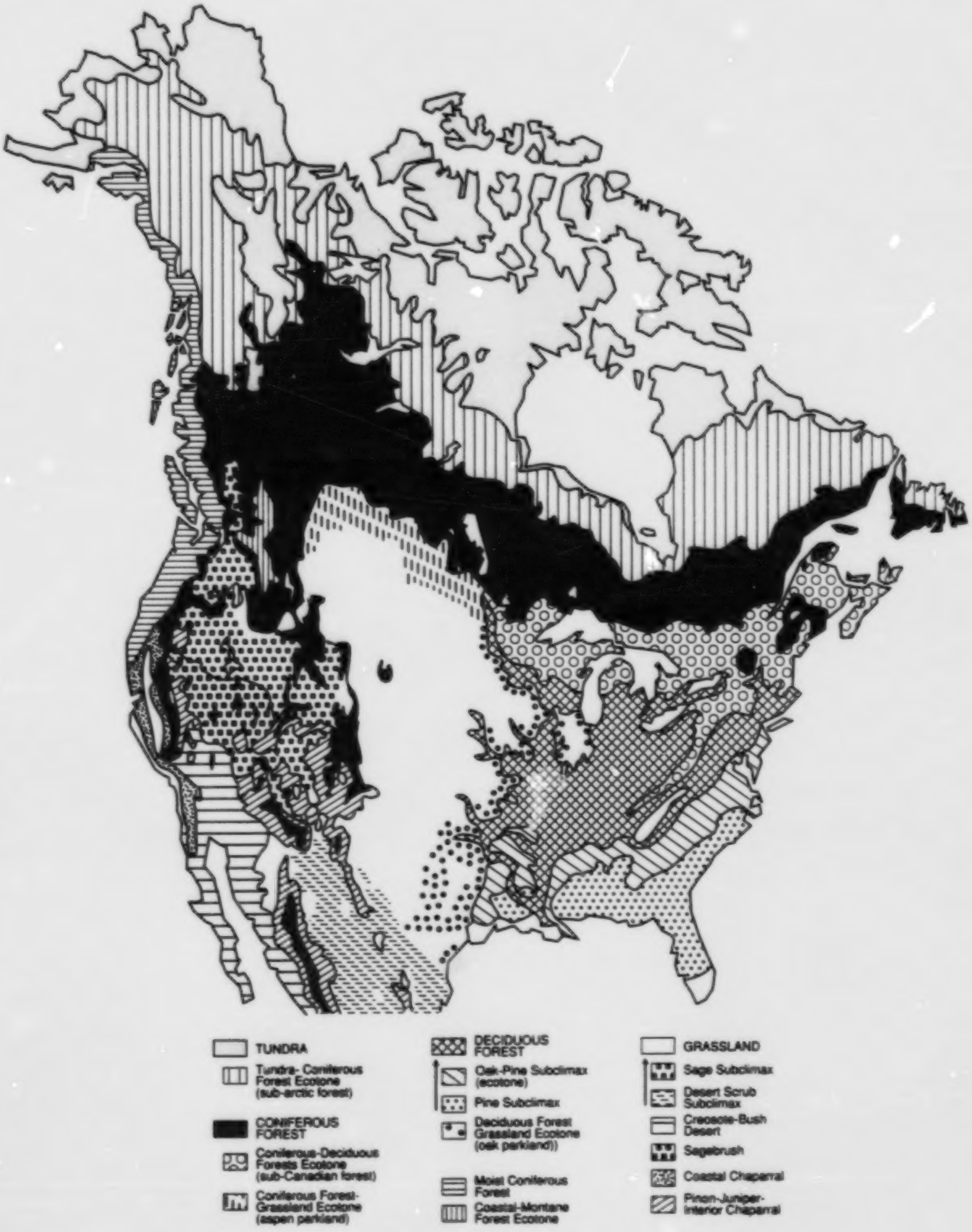
TUNDRA
Tundra- Coniferous Forest Ecotone (sub-arctic forest)
CONIFEROUS FOREST
Coniferous-Deciduous Forests Ecotone (sub-Canadian forest)
Coniferous Forest-Grassland Ecotone (aspen parkland)
DECIDUOUS FOREST
Oak-Pine Subclimax (ecotone)
Pine Subclimax
Deciduous Forest Grassland Ecotone (oak parkland))
Moist Coniferous Forest
Coastal-Montane Forest Ecotone
GRASSLAND
Sage Subclimax
Desert Scrub Subclimax
Creosote-Bush Desert
Sagebrush
Coastal Chaparral
Pinon-Juniper-Interior Chaparral

Figure 130. The biomes of North America, with extensive ecotones and certain subregions (zones) indicated (after Odum 1971)

Rowe (1972) placed the Queen Charlotte Islands into a separate sub-category of his Coast Forest Region classification, thereby giving recognition to the distinctiveness of their forest vegetation because of their noteworthy isolation from comparable counterparts on the continental mainland. He described the primary forest associations of this "luxuriant rain forest" as consisting of western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), and western red cedar (*Thuja plicata*), of which the Sitka spruce is the largest tree. Mountain hemlock (*Tsuga mertensiana*) and yellow cypress (*Chamaecyparis nootkatensis*) are the predominant forest species above 450 metres elevation, western yew (*Taxus brevifolia*) and red alder (*Alnus rubra*) attain a status of limited importance near tidewater levels, while more extreme habitats such as rocky and sandy shores, ridges, and muskegs are usually occupied by shore pine (*Pinus contorta* var. *contorta*). Neither Douglas fir (*Pseudotsuga menziesii*), any of the true firs (*Abies* spp.), nor maples (*Acer* spp.) are said to be native to the Islands (Rowe 1972).

In his general survey of the floral regions of Canada , Scoggan (1978) provided full recognition of the unique environmental factors that gave rise to the "Coast Forest Region" by stating that they are tantamount to an "invisible cage". He reaffirmed and expanded Rowe's (1972) species descriptions by including characteristic shrub, herb, and fern species, as for example *Mecodium wrightii*. This member of the Filmy Fern Family (*Hymenophyllaceae*) is apparently native to the Queen Charlotte Islands and is the only Canadian representative of a family that is predominantly of the southern hemisphere.

The fossil record of the coal seams within the Yakoun Formation provides evidence of the presence of well-developed forests on the Islands, as long ago as the Middle Jurassic Period, in the form of cycad wood (Cycadeocarpus), pollen and spores (Mathewes 1989). Further evidence of exotic, ancient plants of Late Tertiary age, and long since extirpated from this part of the Pacific west coast by changing climatic conditions, was found as fossil material in the Skonun Formation. With the onset of a much colder climate leading to ice age conditions during the Early Quaternary Period, the local fossil record of plants became disrupted. It is not until the glacial maximum of the Wisconsin Period that the record of plant remains continues. Pollen from a Subalpine coniferous forest consisting of spruce, mountain hemlock, and fir species were unearthed by researchers on Graham Island, who subsequently were able to assign an age to the pollen of 45,700 to 27,500 years before the present. The fossil record remains thus far hidden for the period from 27,500 to 16,000 years ago, but resumes around 16,000 years ago (Mathewes, 1989). While not confirmed to date by scientific evidence, radiocarbon dates and micro- and macro-fossils found seem to indicate the possible presence of an ice-free refugium for plants and animals during that period of time. Cores taken from lakes and peat bogs on Graham Island have aided the understanding of the changes that have occurred within Holocene vegetations. Similar studies have been conducted or are underway along the west coast of Moresby Island, but to date no reports have been made available for scrutiny (Mathewes 1989).

A large number of botanists and foresters have over the years collected and provided a wealth of botanical and related descriptive, silvicultural, and managerial information; *i.e.*, Hall 1937; Calder & Taylor 1968; Taylor & Mulligan 1968; Stein & Gerrath 1969; Schofield 1969, 1976; Stewart 1977; Waring & Franklin 1979; Inselberg 1979; Mathewes 1980; Klinka *et al.* 1981; Lewis 1982; Banner *et al.* 1983; Roemer & Ogilvie 1983; Haeussler *et al.* 1984; Pojar *et al.* 1984; Poulin 1984; Unger & Humphreys 1981, 1982, 1983, 1984; Carr 1983; Coates *et al.* 1985; Nordstrom *et al.* 1985; Unger & Stewart 1985, 1986; Carter & Klinka 1986; Krag *et al.* 1986; Nyberg *et al.* 1986; Sanders & Wilford 1986; Smith *et al.* 1986; Banner *et al.* 1987; Meidinger 1987; Humphreys & Ferris 1987; Campbell & Bradfield 1988; Raedeke 1988; Schofield 1988?; Banner *et al.* 1989; Mathewes 1989; Taylor 1989, to mention but a general and limited cross-section of contributors.

Notwithstanding the fine scientific contributions already mentioned, it is widely recognized that the most definitive botanical works for the entire area of the Queen Charlotte Islands, were produced in 1968 by the research teams of Calder & Taylor and Taylor & Mulligan. In fairness to the authors of most of the other references mentioned, their contributions to the botanical sciences were supported by and directed towards more or less site-specific commercial, managerial, and environmental ventures and projects which presently appear to have little or no practical applications to the management and administration of the recently established South Moresby/Gwaii Haanas National Park Reserve; that is, other than to ensure that certain now obvious environmental mistakes are not repeated.

A. TERRESTRIAL VEGETATION RESOURCES

Calder & Taylor (1968), in their treatise of the flora of the Queen Charlotte Islands, were the first researchers to present a chronological listing of individuals who since 1866 collected plant materials on the Islands for botanical study. Following is an abbreviated version of their listing:

Robert Brown, 1866.
Collected some plant specimens on a trading voyage to Moresby Island.

George M. Dawson, 1878.
Conducted a botanical survey of the Islands for the Geological Survey of Canada. A total of 76 taxa were collected and identified by Prof. J. Macoun. The collection is housed at the National Museum in Ottawa.

James G. Swan, 1883.
Collected biological specimens on the Islands for the United States Fish Commission and Bureau of Ethnology. He collected 24 vascular plant taxa in the vicinity of Masset. The collection is housed at the U.S. National Museum in Washington.

Franz Boas, 1888-1897.
Anthropologist and linguist by profession, he collected a number of vascular plants while studying the Haida culture. The collection is housed either in the New York Botanical Garden or the U.S. National Museum inWashington.

Rev. J.H. Keen, 1898-1898.
While missionary at Masset, he collected bird records, insects, and plant specimens. His plant collection is housed at the New York Botanical Museum.

C.F. Newcombe, 1895-1923.
This medical doctor and amateur anthropologist collected plant specimens for ten years, mostly at lower elevations on the Islands. His collections are housed at the Royal British Columbia Museum in Victoria.

Wilfred H. Osgood, 1900.
Conducted a biological exploration of the Islands for the United States Department of Agriculture. Osgood was accompanied by EdmundHeller when he collected 140 taxa which were identified by F.V. Coville of the U.S. National Museum, and are housed there for safekeeping.

W. Spreadborough, 1910.
Was commissioned by the government to collect biological specimens on the Islands. His collection is housed at the National Museum in Ottawa.

C. de B. Green, 1912-1914.
Collected a number of plant specimens while surveying on the Islands for the British Columbia government. His collection is housed in the University of British Columbia in Vancouver.

W.A. Newcombe, 1925.
Made a few collections which are now housed in the Royal British Columbia Museum in Victoria.

Rev. C.J. Young, 1926-1929.
Collected some botanical specimens while visiting the Islands for birdwatching purposes. His specimen are housed in the Royal British Columbia Museum in Victoria.

R.W. Pillsbury, 1951, 1952.
Collected a small number of botanical specimens while conducting an intertidal biotic study for the University of British Columbia. His collection rests in the herbarium there.

I. McTaggart Cowan, 1951.
Made a small collection of vascular plants; the specimens are now housed at the Royal British Columbia Museum in Victoria.

C. J. Guiget, F.L. Beebe, R.L. Schmidt, W. Ziller, 1952.
Small collections of vascular plants were made by each individual; the specimens are now housed at the Royal British Columbia Museum in Victoria.

T.B. Widdowson, 1956.
Made a small collection of vascular plants; the specimens are now housed in the Royal British Columbia Museum in Victoria.

A.S. Brown, 1952-1960.
Made botanical observations and collected some plant specimens, and obtained excellent colour slides of plants and plant associations during the course of his geological surveys for the provincial Department of Mines & Petroleum Resources.

J.A. Calder, D.B.O. Savile, R.L. Taylor, 1957.
Members of the Plant Research Institute at Ottawa conducted an extensive botanical survey of the Islands, during which they collected 2959 specimen numbers, mounted on approximately 15,000 sheets.

H. Persson, 1957.
This member of the Swedish Museum of Natural History joined a botanical survey party of the Canadian Plant Research Institute and collected a large number of bryophytes.

E. Mills, 1957.
This summer student for Dr. E.L. Bousfield of the National Museum of Canada collected a few vascular plants along the west coast of Moresby Island. The specimens are housed at the Department of Agriculture herbarium in Ottawa.

J.B Foster & P. Joslin, 1960.
Collected a number of vascular plants during their land mammal survey of the Islands. The specimens are housed at both the University of British Columbia in Vancouver and at the herbarium of the Department of Agriculture in Ottawa.

J.B. Foster , M. Bigg, 1961.
Collected a number of vascular plants and deposited them at the same institutions chosen following the 1960 survey by Foster and Joslin.

W.B. Schofield, 1961, 1962, 1964.
Collected bryophytes while accompanying J.B. Foster in 1961; conducted his own survey and collections in 1962, and teamed up with J.A. Calder & R.L. Taylor for a few weeks in 1964. Specimens collected are housed at the herbarium of the University of British Columbia in Vancouver.

J.A. Calder, R.L. Taylor, 1964.
Conducted a summer survey of the Islands for the Plant ResearchInstitute, Ottawa, during which they collected 2424 specimen numbers mounted on approximately 10,000 sheets. In addition, 1600 collections were made of cytological plant materials. The collections are housed at the Institute.

L.C. Sherk, 1964.
Joined the Calder & Taylor botanical survey party for two weeks in 1964 to collect living plant specimens for the Canadian Botanical Garden at Ottawa.

A. Vaarma, 1964.
Joined the Calder & Taylor botanical survey party for two weeks in 1964 . This member of the Botany Department of the University of Turku, Finland, collected cytological and herbarium specimens of bryophytes and vascular plants. The disposition of the specimens is not self-evident.

More recently published botanical research works have extended the chronological treatise of the flora of the Queen Charlotte Islands into the 1980's.

J.R. Stein & J.F. Gerrath, 1969.
This study was part of an overall survey of the freshwater algae of British Columbia. The authors published the findings of their earlier collections in Syesis, Vol. 2. The specimens are believed to be housed in the University of British Columbia, Vancouver.

H.L. Roemer & R.T. Ogilvie, 1980.
Collected a number of previously unrecorded plant specimens from limestone areas on the Islands. The specimens are assumed to be housed at the herbarium of the Royal British Columbia Museum in Victoria.

Taylor (1989), co-leader of the major botanical surveys conducted on the Queen Charlotte Islands made the following comment at a relatively recent symposium:

The Islands clearly represent an enigma in the vascular flora of Canada because of the pesence of endemic taxa.

His statement expresses the concern that questions still need to be answered about the extent of the endemic species prior to the last glaciation; whether they represent end products of speciation brought about by insular isolation or they are remnants of taxa widespread in pre-glaciation times, what their corridors of immigration and emigration were during post-glacial times, and why are some species quite common on the mainland while being absent from the Islands.

Even so, the considerable and collective fieldwork had by 1984 (Taylor 1989) resulted in a known vascular plant flora of 611 taxa which represent more than 270 genera and over 69 families. Taylor (1989) further refined the phytogeographic relationships of the vascular plants on the Queen Charlotte Islands by discussing their global distribution; *i.e.* :

Distribution: No. of Taxa:

North America - 248

North America / Asia - 91

North America / South America - 4

North & South America / Europe - 1

Circumpolar / Circumboreal - 140

Introduced Species - 127

Total: 611

The overall composition of the flora is such that the indigenous plants account for approximately 80 percent of the total, while the introduced plants are believed to presently account for 20 percent. Also, of the 611 taxa known to occur on the Queen Charlotte Islands, 86 percent are perennials, 2 percent are biennials, while 11 percent are annuals. In the phytogeographic discussion by Calder & Taylor (1968) of their plant survey of the Islands, they stated that there were 144 species and infraspecific taxa which they considered to be wide-ranging species that occurred either throughout or almost throughout the Islands on diverse habitats. They recognized a second category of 122 species and infraspecific taxa, comprised primarily of Montane elements including "all" of the endemic species of the Islands which were as a category essentially restricted to the Queen Charlotte Ranges and mountainous areas of the Skidegate Plateau. A third category of 72 species and intraspecific taxa is essentially restricted to shores and is comprised of species that almost without exception tolerate saline or brackish conditions. A fourth category of 115 species and intraspecific taxa is comprised of plants that are essentially restricted to open habitats within the lowlands of eastern Graham and eastern Moresby Islands, such as open forests, marshes, mires, bogs, lake shores, river margins, and sea bluffs. Many of these lowland elements are said to be near the limit of their range, and occupy ecological niches of local occurrence. This latter category is also believed to have entered the Islands not before coniferous forests had become established following deglaciation and presumably under the climatically favourable conditions of the Hypsithermal.

In their treatise on the rare vascular plants of British Columbia, Straley *et al.* (1985) pointed out:

a) that the outer Pacific coast of Vancouver Island, the Queen Charlotte Islands, and some other coastal islands provided the habitat conditions for a number of more "southern" West Coast floral elements to reach their northern limits in the province; *e.g.* ,*Disporum smithii, Lasthenia minor, Myrica californica, Oxalis oregana, Poa kelloggii, Polypodium scouleri, Selaginella oregana;* and . . . . .

b) that the Queen Charlotte Islands and adjacent islands are the southern and eastern extensions for a number of "northern" Pacific Rim species that occur along coastal areas from British Columbia to Japan; *e.g.* , *Cerastium fisherianum, Draba hyperborea, Epilobium hornemannii* subsp. *behringianum, Geum calthifolium, Huperzia selago* var. *miyoshianum, Mecodium wrightii.*

Straley *et al.* (1985) provided the botanical information from which the following listing of rare terrestrial plants within the Queen Charlotte Islands could be prepared:

RARE TERRESTRIAL PLANTS

Species:	Common Name:	Habitat:
Agrostis pallens	Dune Bent Grass	Coastal woods
Botrychium minganense	Mingan Grape Fern	Woods, fields
Carex arenicola	Sand Dune Sedge	Rocky bluffs
Castilleja hyetophila	Coastal Red Indian Paintbrush	Low meadows
Cerastium fisherianum	Fisher's Chickweed	Hillsides
Douglasia laevigata	Smooth Douglasia	Talus slopes, bluffs
Draba lonchocarpa var. *vestita*	Lance-fruited Whitlow Grass	Rock crevices
Epilobium hornemannii ssp. *behringianum*	(Willowherb)	Rocky cliffs
Hammarby paludosa	Bog Adder's-mouth Orchid	Bogs, muskegs
Juncus biglumis	Two-flowered Rush	Wet tundra
Lathyrus littoralis	Gray Beach Peavine	Dunes
Malaxis monophyllus var. *diphyllos*	White Malaxis	Boggy areas
Mecodium wrightii	Wright's Filmy Fern	Boulders, cliffs
Oxalis oregana	Redwood Sorrel	Moist woods
Platanthera unalascensis ssp. *maritima*	Maritime Alaska Rein Orchid	Cliffs, dry hills
Polystichum setigerum	(Sword Fern)	Lowland forests
Salix reticulata ssp. *glabellicarpa*	Netted Willow	Alpine tundra
Senecio moresbiensis	Queen Charlotte Ragwort	Rocky, boggy slopes
Sparganium glomeratum	(Bur-reed)	Boggy pools
Stipa lemmonnii	Lemmon's Needle Grass	Valleys
Swertia perennis	Alpine Bog Swertia	Meadows, banks
Triglochin concinnum	Graceful Arrow-grass	Meadows, marshes
Viola biflora ssp.	Queen Charlotte Twinflower Violet	Alpine meadows

Calder & Taylor (1968) were the first researchers to attempt to arrange the vegetation of the Queen Charlotte Islands in descriptive plant communities on the basis of topographic features, major vegetation types, and the relative abundance of the plant species within the community. It was not until the early 1980's that members of the British Columbia Ministry of Forests (Lewis 1982; Haeussler *et al.* 1984; Pojar *et al.* 1984) took up the task of carrying the classifying of forest ecosystems in the Prince Rupert Forest region to a higher level of ecological complexity and understanding. Banner *et al.* (1989) consolidated the collective knowledge of the day when they described the generalized terrestrial ecosystems of the four biogeoclimatic zones said to occur on the Queen Charlotte Islands as a whole; *i.e.*:

- Coastal Western Hemlock Zone - **CWH** (Krajina 1970), classified into 14 terrestrial ecosystems.
- Coastal Cedars - Pine - Hemlock Zone - **CCPH** (Pojar & Annas 1980; Pojar 1983), classified into 12 terrestrial ecosystems.
- Mountain Hemlock Zone - **MH** (Brooke *et al.* 1970),
- Alpine Tundra Zone - **AT** (Krajina 1970)

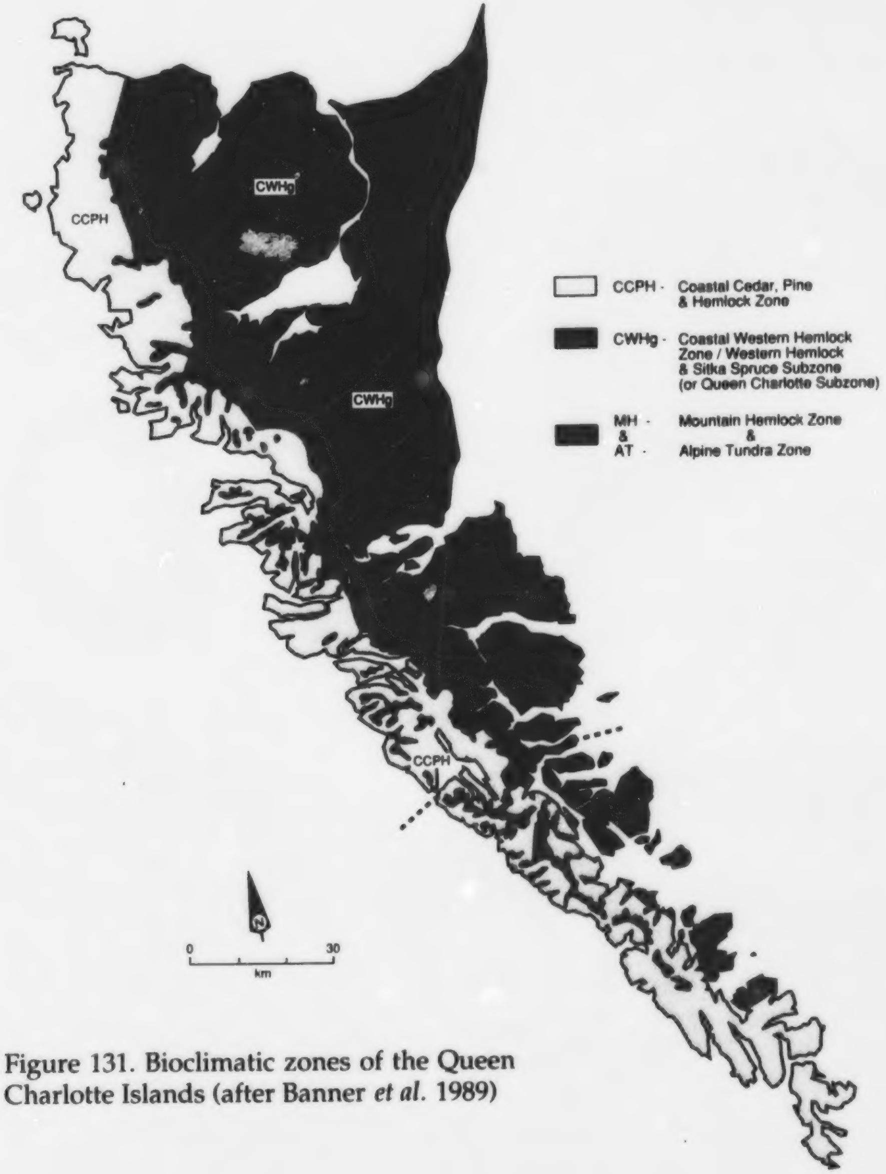
CCPH
CWHg
CWHg
CCPH
CCPH - Coastal Cedar, Pine & Hemlock Zone
CWHg - Coastal Western Hemlock Zone / Western Hemlock & Sitka Spruce Subzone (or Queen Charlotte Subzone)
MH & AT - Mountain Hemlock Zone & Alpine Tundra Zone
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Figure 131. Bioclimatic zones of the Queen Charlotte Islands (after Banner *et al.* 1989)

Coastal Western Hemlock Zone

Ecosystem Associations:

(1) Dry Cedar - Salal =
Thuja plicata - Tsuga heterophylla - (Pinus contorta) - Gaultheria shallon - (Vaccinium parvifolium) - Rhytidiadelphus loreus - Stokesiella oregana - Hylocomium splendens

(2) Spruce Reedgrass Seacoast Forests =
Picea sitchensis - (Gaultheria shallon) - Calamagrostis nutkaensis

(3) Spruce Beach / Dune Forests =
Picea sitchensis - Stokesiella oregana

(4) Spruce - Hemlock - Sword Fern =
Picea sitchensis - Tsuga heterophylla - (Thuja plicata) - Polystichum munitum - (Dryopteris assimilis) - Rhytidiadelpus loreus - (Stokesiella oregana) - (Leucolepis menziesii)

(5) Zonal Hemlock - Moss =
Tsuga heterophylla - Thuja plicata - (Picea sitchensis) - (Taxus brevifolia) - (Vaccinium alaskaense - V. parvifolium - V. ovalifolium) - Rhytidiadelphus loreus - Hylocomium splendens - Rhizomnium glabrescens

(6) Montane Zonal Hemlock - Moss =
Tsuga heterophylla - Chamaecyparis nootkatensis - (Picea sitchensis - Thuja plicata) - (Vaccinium ovalifolium - V. alaskaense - V. parvifolium) -Huperzia selago - Scapania bolanderi - Rhizomnium glabrescens - Dicranum fuscescens

(7) Alluvial Spruce - Grass =
Picea sitchensis - (Tsuga heterophylla - Alnus rubra) - Trisetum cernuum - Melica subulata - Hylocomium splendens - Leucolepis menziesii

(8) Hemlock - Spruce - Foamflower - Oak Fern =
Tsuga heterophylla - Picea sitchensis - (Vaccinium alaskaense - V. ovalifolium - V. parvifolium) - Tiarella trifoliata - Gymnocarpium dryopteris - Hylocomium splendens - Rhytidiadelphus loreus – Rhizomnium glabrescens

(9) Montane Hemlock Cypress - Oak Fern =
Tsuga heterophylla - Chamaecyparis nootkatensis - (Thuja plicata - Picea sitchensis) - Gymnocarpium dryopteris - Huperzia selago - Conocephalum conicum - Pellia neesiana - Pogonatum alpinum

(10) Poor Cedar - Hemlock - Salal =
Thuja plicata -Tsuga heterophylla -Gaultheria shallon - (Vaccinium alaskaense - V. ovalifolium - V. parvifolium) - Rhytidiadelphus loreus - Hylocomium splendens - (Sphagnum girgensohnii)

(11) Cedar - Cypress Scrub =
Thuja plicata - Chamaecyparis nootkatensis - Tsuga heterophylla - (Tsuga mertensiana - Pinus contorta) - Gaultheria shallon - Carex anthoxanthea - Rhytidiadelphus loreus - Hylocomeum splendens - Sphagnum girgensohnii

(12) Cedar - Skunk Cabbage Swamps =
Thuja plicata - Picea sitchensis - (Tsuga heterophylla) - Lysichiton americanum - Hylocomium splendens - Rhytidiadelphus loreus - Sphagnum girgensohnii - Conocephalum conicum - Pellia neesiana

(13) Montane Hemlock - Cypress - False Hellebore - Liverwort =
Tsuga heterophylla - Chamaecyparis nootkatensis - Picea sitchensis - (Tsuga mertensiana) - Veratrum viride - (Gymnocarpium dryopteris) - Conocephalum conicum - Pellia neesiana - Leucolepis menziesii - Rhizomnium glabrescens - Rhytidiadelphus loreus

(14) Topogenous Bogs =
Pinus contorta - Ledum groenlandicum - Juniperus communis - Carex livida - Trichophorum caespitosum - Sphagnum rubellum

Coastal Cedars - Pine - Hemlock Zone

Ecosystem Associations:

(1) Dry Shore Pine - Juniper - Lichen = *Pinus contorta - Thuja plicata - Juniperus communis - Gaultheria shallon - Empetrum nigrum - Rhacomitrium lanuginosum - Pleurozium schreberi - Cladina impexa*

(2) Submesic Cedar - Cypress - Hemlock - Shore Pine - Salal - Moss = *Thuja plicata - Chamaecyparis nootkatensis - Tsuga heterophylla - Pinus contorta - Gaultheria shallon - Blechnum spicant - Rhytidiadelphus loreus - Hylocomium splendens - Stokesiella oregana*

(3) Spruce - Salal - Reedgrass Seacoast Forests = *Picea sitchensis - Thuja plicata - Gaultheria shallon - Calamagrostis nutkaensis*

(4) Hemlock - Cedar - Vaccinium - (Deer Fern) - Moss = *Tsuga heterophylla - Thuja plicata - (Picea sitchensis) - Vaccinium parvifolium - V. alaskaense - Menziesia ferruginea - Rhytidiadelphus loreus - Hylocomium splendens – Rhizomnium glabrescens*

(5) Zonal Cedar - Cypress - Hemlock - Vaccinium - Salal - Moss = *Thuja plicata - Chamaecyparis nootkatensis - Tsuga heterophylla - Vaccinium parvifolium - V. alaskaense - Gaultheria shallon - Blechnum picant - Rhytidiadelphus loreus - Rhizomnium glabrescens - Sphagnum girgensohnii*

(6) Hemlock - Cedar - Spruce -Foamflower - Oak Fern - Lady Fern = *Tsuga heterophylla - Thuja plicata - Picea sitchensis - Menziesia ferruginea - Vaccinium parvifolium - V. alaskaense - Tiarella trifoliata - Gymnocarpium dryopteris - Athyrium filix-femina - Rhytidiadelphus loreus - Hylocomium splendens - Rhizomnium glabrescens*

(7) Alluvial Spruce - Grass = *Picea sitchensis - Tsuga heterophylla - Thuja plicata - Alnus rubra - Trisetum cernuum - Melica subulata - Rhytidiadelphus loreus - Hylocomium splendens - Pogonatum alpinum - Plagiomnium insigne*

(8) Cedar - Cypress - Skunk Cabbage Swamp Forest = *Thuja plicata - Chamaecyparis nootkatensis - (Tsuga heterophylla) - Menziesia ferruginea - Gaultheria shallon - Lysichiton americanum - Rhytidiadelphus loreus - Hylocomium splendens - Pellia neesiana - Sphagnum girgensohnii*

(9) Cedar - Cypress - Pine Bog Forests = *Thuja plicata - Chamaecyparis nootkatensis - Pinus contorta - Tsuga heterophylla - Gaultheria shallon - (Ledum groenlandicum) - Blechnum spicant - Calamagrostis nutkaensis - Vaccinium vitis-idaea - Rhytidiadelphus loreus - Sphagnum girgensohnii - S. rubellum*

(10) Pine - Cypress - Cedar Bog Woodland = *Pinus contorta - Chamaecyparis nootkatensis - Thuja plicata - Gaultheria shallon - Ledum groenlandicum - Kalmia microphylla - Fauria crista-galli - Empetrum nigrum - Rhytidiadelphus loreus - Pleurozium schreberi - Sphagnum girgensohnii - S. rubellum - S. papillosum*

(11) Topogenous Sphagnum Bogs = *Kalmia microphylla - Ledum groenlandicum - Trichophorum cespitosum - Trientalis europaea - Vaccinium oxycoccus - Sphagnum rubellum - S. papillosum - S. lindbergii*

(12) Pine - Cypress Open Blanket Bogs = *Pinus contorta - Chamaecyparis nootkatensis - Juniperus communis - Ledum groenlandicum - Trichophorum caespitosum - Empetrum nigrum - Carex livida - Drosera rotundifolia - Sphagnum rubellum - S. papillosum - Cladina impexa - Siphula ceratites - Rhacomitrium lanuginosium*

Mountain Hemlock Zone

Ecosystem Associations:

(1) Zonal Hemlock Forests = *Tsuga mertensiana* - *Tsuga heterophylla* - *Chamaecyparis nootkatensis* - *Vaccinium alaskaense* - *V. ovalifolium* - *Coptis asplenifolia* *Rhytidiadelphus loreus*

(1a) Drier Hemlock Forests = have fewer forbs and more *Rhytidiopsis robusta* and *Dicranum* spp.

(1b) Wetter Hemlock Forests = have more *Chamaecyparis nootkatensis*, forbs, liverworts and *Sphagnum girgensohnii*

(2) Windward Forests = *Tsuga mertensiana* - *Calamagrostis nutkatensis* - *Picea sitchensis* - *Lepidozia filamentosa*

(3) Non-Forested Ecosystems = include heather and herb meadows in high elevation parklands near tree line, and blanket bog communities.

Alpine Tundra Zone

Ecosystem Associations:

(1) Herb Meadows = *Senecio triangularis* - *Heracleum sphondylium* - *Erigeron peregrinus* - *Veratrum viride* - *Calamagrostis nutkaensis* - *Carex macrochaeta* - *Dodecatheon jeffreyi* - *Luetkea pectinata*

(2) Alpine Heaths = *Cassiope lycopodioides* - *C. mertensiana* - *C. stellariana* - *Phyllodoce glanduliflora* - *Vaccinium caespitosum*

(3) Rocky Steeplands = sparsely vegetated habitats on talus slopes rock outcrops cliffs, and wet runnels, that provide habitats for many endemic, rare, and disjunct species as described by Calder & Taylor (1968).

While many forested lands licenced to be logged have been classified in some manner employing Krajina's (1970) biogeoclimatic classification system, up to this period in time, no ecological (biophysical) land classification studies as per Lacate's (1969) guidelines are known to have been conducted on the Queen Charlotte Islands. In keeping with its park policy, the Canadian Parks Service is contemplating the initiation of such work for the South Moresby / Gwaii Haanas National Park Reserve in the very near future, for both the terrestrial and marine components of the park reserve.

Meanwhile, the activity of commercial logging has largely modified vast tracts of land and severely disrupted the natural vegetation communities of many parts of both Graham and Moresby Islands, because of the clear-cutting method utilized. Banner *et al.* (1989) indicated that of the Crown lands designated as timber supply area (TSA) and tree farm licence (TFL), only 65 percent can be classed as productive forest lands. The remainder consists of uncommercial scrub forests, alplands, water, and areas that do not support tree growth. The same authors stated that, of the productive forest lands about 15 percent had been denuded by the mid-1980's, and that most the logging had been concentrated in the more productive Coastal Western Hemlock (CWH) biogeoclimatic zone; but small areas within the Coastal Cedars-Pine-Hemlock (CCPH) biogeoclimatic zone have also been intensively logged. Thus, clearcut logging on Graham Island has mainly affected Mamin River and Yakoun River watersheds, the Juskatla, Dinan Bay, Naden Harbour, Eden Lake, Davidson Creek, and Rennell Sound areas. On Moresby Island, the triangle of Skidegate Inlet - Mosquito Lake - Cumshewa Inlet has been heavily logged, as have been the slopes of Sewell Inlet, Newcombe Inlet, Tangil Peninsula, Talunkwan Island, and Lyell Island, to mention the major concentrations of natural resource extraction activities. Apparently only 7 percent of the total logged areas have been replanted, mostly with Sitka spruce, while the remainder of the clearcut areas appear to have to rely on natural regeneration to restock them with vegetation communities and check the active erosional processes on many of them.

As might be surmised, the removal of the forest cover and the construction of roads and cat trails has had a general and often very dramatic impact on the physical stability of the slopes that were denuded. In some instances, and aided by rainfall-saturated soils on steep slopes as well as seismic activity, the geomorphic processes of mass wasting have caused massive and extensive topographic, botanical, and stream habitat alterations, often with devastating results. Several researchers have addressed this problem (Bustard 1984; Klassen 1984; Poulin 1984; Rood 1984; Carr 1985; Hogan 1986; Karanka 1986; Krag *et al.* 1986; Sanders & Wilford 1986; Smith *et al.* 1986; Tripp & Poulin 1986a, 1986b; Roberts 1987; Sauder *et al.* 1987; Gimbarzevsky 1988). Only Gimbarzevsky's (1988) work includes the entire area of the South Moresby / Gwaii Haanas National Park Reserve and provides an assessment of the normal mass wasting potential of unlogged slopes.

a) RESOURCE ANALYSIS

The excellent botanical legacy left by the works of Calder and Taylor (1968) will stand forever as the definitive, though broad, statement about the flora of the Queen Charlotte Islands. Without a doubt, other botanists have already, and will continue into the future, to add new taxonomic data to what the earlier workers established as the primary data base. Few areas in Canada have undergone a similarly rigorous study and documentation than have the Islands. The resource managers of the South Moresby / Gwaii Haanas National Park Reserve ought to consider themselves fortunate to be able to commence their protection and preservation activities with such a data base to refer to.

In more recent years, a large number of university students and professors, logging company employees, foresters, and an assortment of other professionals, have amassed a sizable collection of thematic botanical information, ranging from discussions about merchantable timber species to algae, and from forest insect diseases and insect infestations to forest rehabilitation. Another group of provincial forest officers undertook to view and describe forest communities on the Queen Charlotte Islands in an ecological (biophysical) land classification context. Much of this work is to be admired, especially when one considers the physical hardships endured in rough and difficult to access, remote, virgin territory, to gather and measure the scientific information.

Yet, when considering the application of the available information base to the newly established national park reserve, two points worth noting become clear:

1) most of the botanical, ecological, and technical information about the vegetation of the Islands, relate by virtue of the purposes for which the studies were initiated in the first place, to the inhabited and generally logged portions of Graham and Moresby Islands, and do not for the most part include any discussions of the flora of the national park reserve;

2) those disparate pieces of vegetation information relating to the national park reserve, are currently not of the type and depth required by modern park officers to manage a national park in accordance with the requirements of the National Park Policy.

For the resource managers of the South Moresby / Gwaii Haanas National Park Reserve to achieve the policy-assigned vegetation management roles, it will be necessary to further enhance the existing data base by initiating an all inclusive ecological land classification inventory that will provide the information required.

- Management Concerns

A number of vegetation resources-related management concerns can be cited; however, some of them appear to be more important at this stage in the development of a resource management strategy for the national park reserve than are others. For instance, in the absence of a natural resource inventory describing the vegetation associations in some considerable detail, it is inappropriate to address any but the most obvious and pressing vegetation management concerns here at this time.

The primary outstanding concern requiring resolution is the prompt acquisition of an ecological (biophysical) land classification at a scale and detail that would allow rational vegetation and land management decisions to be made. The botanical information base currently available for the South Moresby / Gwaii Haanas National Park Reserve is not suitable for that purpose, and in all fairness to the researchers that provided it, was not collected with park management requirements in mind.

Another important park management planning concern relating to the vegetation resources is that of how proposed recreational activities and facilities might be affected by or themselves affect the naturally occurring vegetations and the geomorphic processes of mass wasting. Linked to this concern are the requirements to maintain high levels of public safety while providing for travel through and camping in vegetation resources, and to keep streams and their fish habitats as free of the devastating impacts of mass wasting activities as is possible through pro-active planning.

The rehabilitation of those vegetated areas within the South Moresby / Gwaii Haanas National Park Reserve previously devasted by logging practices, signifies another important management concern. This very costly activity must out of necessity be guided by sound ecological principles, be supported by Environmental Impact Assessments, and find strong expression in park management and resource management plans.

- Status Of Knowledge

The current academic status of botanical knowledge is sufficient to allow park management planners to commence their broad planning activities (Anon. 1985a) to proceed. Those very activities will set the stage for ecological studies to be identified and conducted, in order to provide sufficiently detailed synecological and autecological information for sound vegetation management to be undertaken. No major terrain and vegetation manipulations should be funded until the present level of botanical and ecological knowledge has been elevated to that level.

b) SELECT REFERENCE SOURCES

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B. MARINE VEGETATION RESOURCES

It is possible to distinguish four types of marine floral communities: Submerged communities, wetland communities, beach communities and rocky shore communities. Submerged oceanic communities both nearshore and offshore are comprised primarily of salt water macroalgae, commonly called seaweeds, as well as a few marine grasses. In estuarine systems, where the fresh water influence is felt and the landscape is subject to periods of wetting and drying, vascular plants other than seaweeds abound, providing a vital food source to migratory waterfowl in particular. A third maritime community is made up of the beaches which, though terrestrial, owe their distinctive flora to the influence of the ocean. And a fourth community is comprised of the spray-washed rocks.

- Littoral Communities

The investigation of the marine flora of the Queen Charlotte Islands is neither so comprehensive nor so longstanding as that of the terrestrial flora. The phycological surveys which do exist are for the most part sporadic. Hawkes *et al.* (1978) provided an overview of the marine algae of the north coast, and some attempts have been made to examine a few of the estuaries in the area, but only one effort has been made to describe phytoplankton distributions (Perry *et al.* 1983).

The majority of the marine vegetation found on and near the British Columbia Coast, which are commonly called seaweeds, belong to the group within the plant kingdom known as algae. The west coast of North America is one of the major areas of kelp forest in the world. While the macroscopic algae may be more readily recognizeable and more easily harvestable than the microscopic algae, the microscopic species can have important consequences for other marine resources. The great variation in physiognomy belies the simplicity of the cellular structure of marine algae. Their requirements for support, moisture, nutrition and dissolved gases are supplied by the sea water, while a root-like structure known as a holdfast acts as an anchor to the sea bottom. The few species of seaweed which are not algae are marine grasses, true vascular plants with an absorbtive root system.

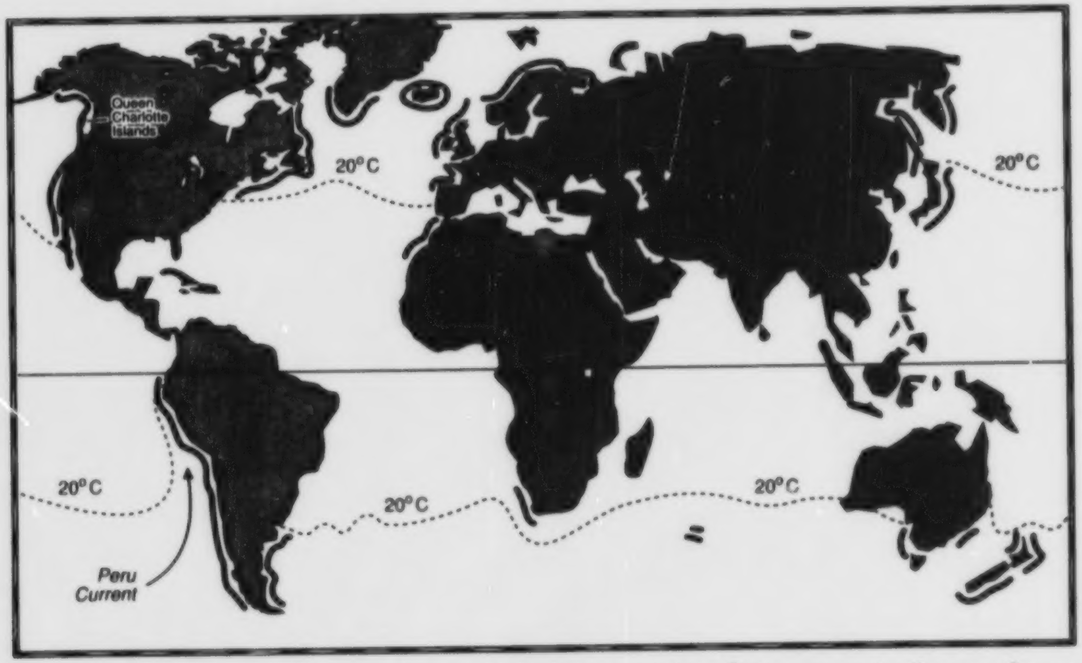

Figure 132. World distribution of major kelp forests with 20°C summer isotherms shown (after Mann 1973)

The most recent, comprehensive study of marine algae of the northern British Columbia coast by Hawkes *et al* . (1978) recognizes 162 red algae (Rhodophyta), 57 brown algae (Phaeophyta), 31 green algae (Chlorophyta), and one golden brown alga (Chrysophyta), a total of 251 species. That number represents about 55 percent of the 476 native species for the whole of the British Columbia coast described by Scagel (1967). It has been postulated (Anon. 1983a) that the larger number of species reported by Lindstrom (1977) for the coast of Alaska may be due to a less intensive sampling in northern British Columbia. However, the discrepancy may also be due to the fact that southeast Alaska may be a major transition zone between the floras of the Pacific coast of the United States and Canada and those of Western Alaska (Scagel 1963). Druehl (1970) places a transition zone in the area of Prince William Sound.

Among the macroalgae, the kelps *Macrocystis* spp. and *Nereocystis* spp. are the most conspicuous. *Macrocystis* spp. tend to grow in more sheltered areas, whereas *Nereocystis* spp. tend to grow in more exposed areas (Searing 1987). Mean biomass of kelp beds for the Queen Charlotte Islands area as a whole is approximately 66 metric tonnes per hectare (Anon. 1983a). The north coast of Graham Island supports some of the largest kelp beds on the British Columbia coast. Coon *et al.* (1979) estimated that 61,528 metric tonnes of kelp (of which 86.44 percent were *Nereocystis* spp.) were available at the mean water line along the surveyed portion of coastline. A previous study by Jenkins and Britt (1972) had announced a standing crop of approximately 127.5 metric tonnes of *Macrocystis* spp. in Skidegate Inlet and 281,527 metric tonnes in Cumshewa Inlet. Within the southeast Moresby area, Searing (1987) identified 157 key areas representing one or more marine theme components. Of those areas, 43 percent had a significant amount of kelp growing in nearshore waters. About 25 percent supported beds of *Nereocystis* spp. and 23 percent supported beds of *Macrocystis* spp.

The macroalgae occupy a variety of habitats in the intertidal and subtidal zones. While some species can survive in the splash zone, the upper limit of their range is commonly the extreme high tide (Scagel 1967). The lower limit is more variable, depending as it does on the translucence of the water, but 30-40 metres below sea level is usual in most British Columbia waters. Searing and English (1983) described the marine flora of the various marine habitats of south Moresby Island according to elevation range.

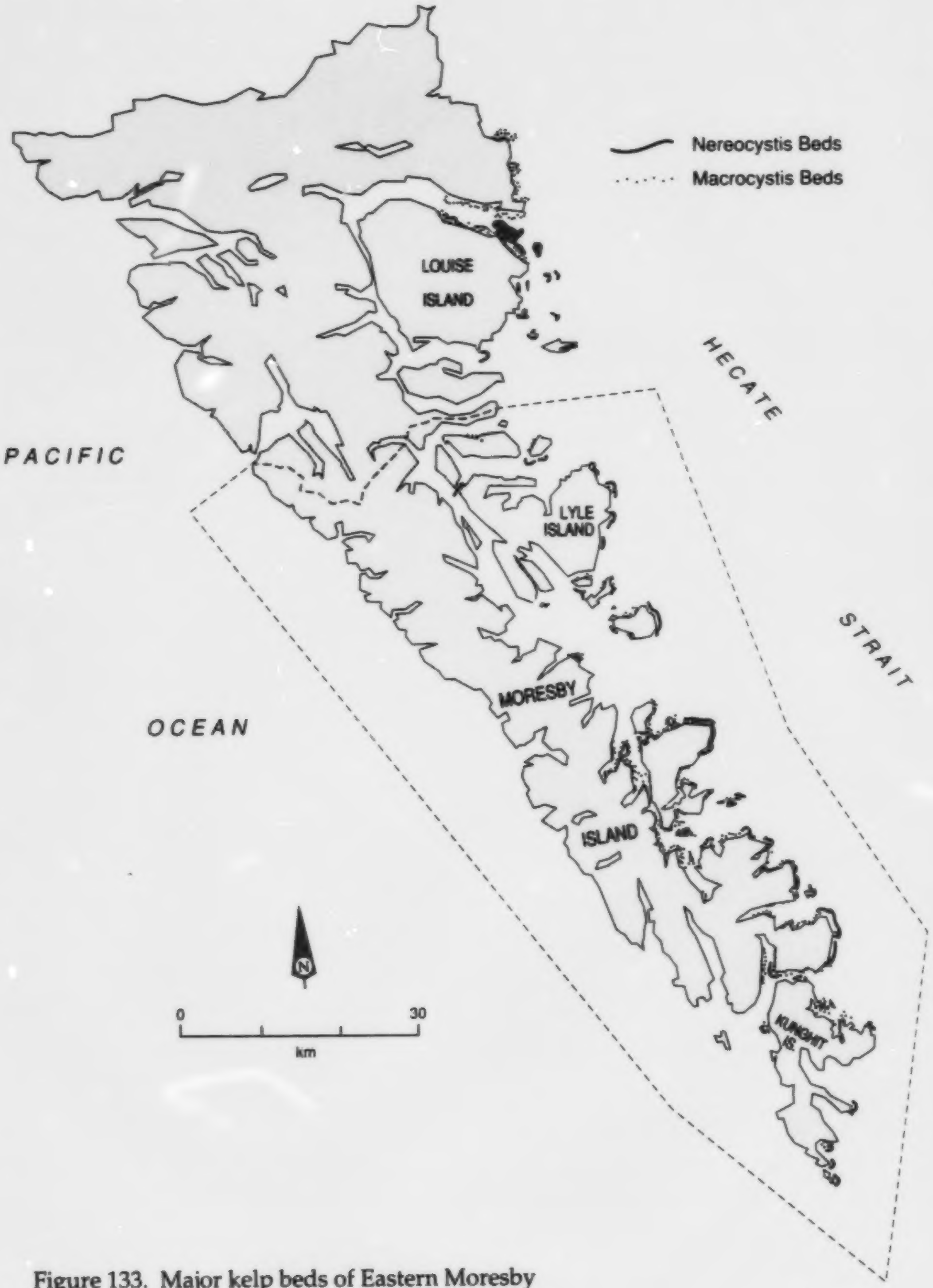
Nereocystis Beds
Macrocystis Beds
LOUISE ISLAND
HECATE
STRAIT
PACIFIC
OCEAN
LYLE ISLAND
MORESBY
ISLAND
KUNGHIT IS.
N
0
30
km

Figure 133. Major kelp beds of Eastern Moresby Island Archipelago (after Searing & English 1983)

Major Marine Plants of South Moresby Island
(after Searing & English 1983)

Habitat:	Percent of shoreline:	Depth (m):	Genera:
Exposed Bedrock/ Boulder	9	0-10	*Laminaria*
		"	*Phyllospadix*
		"	*Lessoniopsis*
		"	*Alaria*
		"	*Desmarestia*
		"	Corraline algae
		10-20	*Nereocystis*
		"	*Laminaria*
		"	*Pleurophycus*
		"	*Desmarestia*
		"	Corraline algae (incl.*Lithothamnion*)
		20-40	*Lithothamnion*
Semi-protected Bedrock	18	2-12	*Egregia*
		"	*Phyllospadix*
		"	*Pterygophora*
		"	*Desmarestia*
		12-25	*Macrocystis*
		"	*Nereocystis*
		"	*Laminaria*
		25-40	*Lithothamnion*
Semi-protected or high current bedrock/cobble	2	2-8	*Egregia*
		"	*Phyllospadix*
			Codium
		8-15	*Nereocystis*
		"	*Cymathere*
		"	*Laminaria groenlandica*
		"	*Desmarestia*
		"	*Ulva*
		"	Corraline algae (incl. *Lithothamnion*)
		15-40	*Ulva*
		"	*Iridaea*
		"	Coralline algae (incl. *Lithothamnion*)
Protected Bedrock/ Sand	20	0-15	*Zostera*
		"	*Ulva*
		"	*Alaria*
		"	Coralline algae
		15-30	*Macrocystis*
		"	*Agarum*
		"	*Laminaria groenlandica*
		"	Corraline algae
		30-40	*Agarum*

Major Marine Plants of South Moresby Island
(after Searing and English 1983)

Habitat:	Percent of shoreline:	Depth (m):	Genera:
Protected Bedrock/ Cobble/Sand	40	0-12	*Fucus*
		"	*Halosaccion*
		"	*Codium*
		12-30	Coralline algae (incl. *Lithothamnion*)
Protected Cobble/Sand	9	5-10	*Zostera*
		"	*Egregia*
		"	*Ulva costaria*
		"	Corraline algae
		10-25	*Macrocystis*
		"	*Nereocystis*
		"	*Laminaria groenlandica*
		"	*Cymanthere triplicata*
		"	*Pterygophora*
		"	Coralline algae (incl. *Lithothamnion*)
		25-40	*Agarum*

Perry *et al.* (1983) believed that nutrients rather than light were the controlling factor in determining phytoplankton biomass in Hecate Strait. They found that phytoplankton distributions in Hecate Strait are affected by tidal mixing and that productivity is highest in the zone between mixed and stratified water masses. Sedimentation of biomass to the benthos is highest along the western shelf. That area of Hecate Strait corresponds to the most productive groundfish region on the British Columbia coast.

Two genera of perennial marine seed plants are represented on the British Columbia coast: *Zostera* (eelgrass) and *Phyllospadix* (seagrass), each with two species or subspecies (Scagel 1967). *Zostera marina marina* and *Z. m. latifolia* show a preference for areas of low salinity, though they can tolerate moderate to high salinity (Phillips 1978). Eelgrass grows throughout the British Columbia north coastal region. Both *Phyllospadix scouleri* and *P. torreyi* grow on open rocky coasts, the latter in deeper water than the former. Only *P. scouleri* is known to extend north of Vancouver Island (Phillips 1979).

- Marine Wetland Communities

The extent of salt marshes on the west coast of North America is relatively broad (Alaska to Mexico) compared to the extent of salt marshes along most coastlines of the world. But that seeming expanse is deceptive, for estuaries and lagoons make up only 10-20 percent of the shoreline on the Pacific coast of North America, as compared for example to the 80-90 percent figure for the Atlantic coast of North America (Macdonald 1977). The reason being that the Pacific coast is a more tectonically active region: Mountain building has left far less room for the coastal lowlands which accomodate salt marshes.

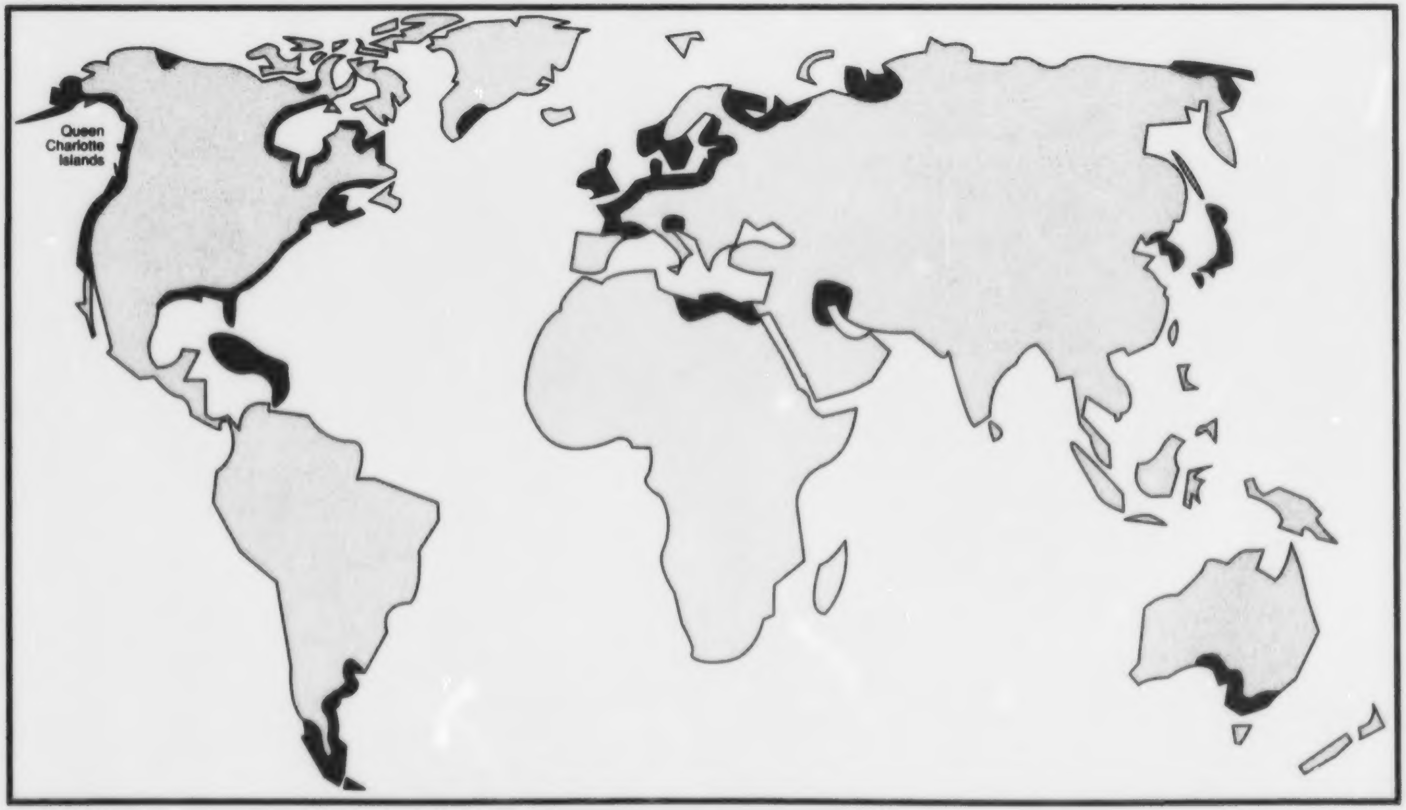

Figure 134. World distribution of salt-marshes (after Chapman 1977)

A survey of the major coastal wetlands of British Columbia conducted by the British Columbia Ministry of the Environment in 1985 (Hunter *et al.*) distinguished 46 coastal wetlands on Moresby Island and the smaller adjacent Islands, of which 27 are within the proposed national park reserve:

Outside Reserve

Head of Fairfax Inlet
Head of Botany Inlet
Edwards Creek Estuary
Slim Creek (Newcombe Inlet)
Head of Kootenay Inlet
Head of Bottle Inlet
Head of Douglas Inlet
Head of Mitchell Inlet
Head of Mudge Inlet
Head of Peel Inlet
Security Cove
Deena River/South Bay
Copper Bay
Pallant Creek Estuary
Lagoon Inlet
Head of Sewell Inlet
Pacofi Bay
Cecil Cove (Big Goose Cr. Estuary)
Crescent Inlet

Inside Reserve

Head of Louscoone Inlet
Head of Flamingo Inlet
Yakulanas Bay
Goski Bay
Anna Inlet
McEchran Cove (Salmon River Estuary)
Echo Harbour
Beresford Inlet
Takelley Cove
Beljay Bay
Powrivco Bay
Windy Bay
De la Beche Inlet
Head of Hutton Inlet
Head of Marshall Inlet
Head of Matheson Inlet
Skatt Harbour
Island Bay
Bag Harbour
George Bay
Head of Slim Inlet
Head of Huston Inlet
Harriet Harbour
Ikeda Cove
Rose Inlet (Sedmond Cr. Estuary)
Heater Harbour
Head of Luxana Inlet

In the southeast Moresby Island area, Searing (1987) noted only six salt marshes of significant size. Five of those are at the heads of major inlets: Pacofi Bay, Thurston Harbour, Crescent Inlet, McEchran Cove and Rose Inlet. The small marsh in Dolomite Narrows is unique in its location along a channel and had not been considered by Hunter *et al*. 1985) in their inventory.

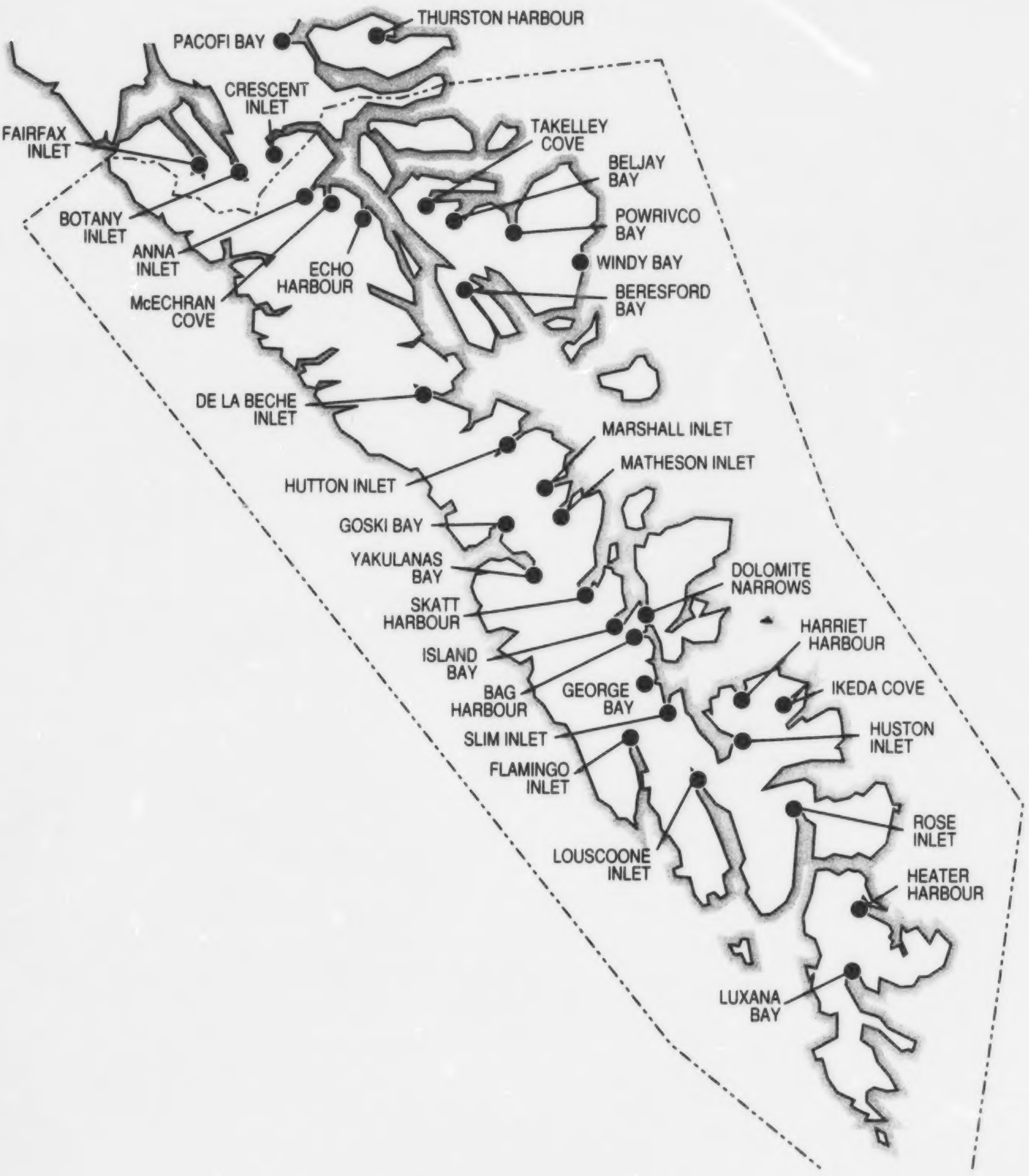
THURSTON HARBOUR
PACOFI BAY
CRESCENT INLET
FAIRFAX INLET
TAKELLEY COVE
BELJAY BAY
POWRIVCO BAY
BOTANY INLET
ANNA INLET
WINDY BAY
ECHO HARBOUR
McECHRAN COVE
BERESFORD BAY
DE LA BECHE INLET
MARSHALL INLET
MATHESON INLET
HUTTON INLET
GOSKI BAY
YAKULANAS BAY
DOLOMITE NARROWS
SKATT HARBOUR
HARRIET HARBOUR
ISLAND BAY
IKEDA COVE
BAG HARBOUR
GEORGE BAY
SLIM INLET
HUSTON INLET
FLAMINGO INLET
ROSE INLET
LOUSCOONE INLET
HEATER HARBOUR
LUXANA BAY

Figure 135. Marine wetlands of South Moresby

British Columbia Provincial Tree Farm Licence (TFL) 24 once covered most of the area of south Moresby Island, including the whole of the proposed national park reserve. Lewis (1982) classified the estuarine ecosystems of the TFL into two saltmarsh types: A *Deschampsia caespitosa* ecosystem type characterized by a complete cover of tufted hairgrass and a *Salicornia virginica - Fucus* ecosystem type dominated by pickleweed and bladder wrack.

Within the *Deschampsia caespitosa* saltmarsh, the minor flora include *Stellaria hemifusa*, *Trifolium wormskjoldii* and *Atriplex patula*. On the highest parts of the marsh, the moss *Stokesiella praelonga* can be found beneath trees. In the somewhat lower *Salicornia virginica - Fucus* saltmarsh, cover is 60-70 percent *Salicornia virginica* . *Puccinellia* spp. make up 20 percent of the cover, and there are sporadic instances of *Glaux maritima*, *Carex phyllomanica*, *Triglochin pallustre* and *Plantago maritima*. Both types of salt marsh provide forage for deer populations and avifauna as well as affording both food and cover for populations to anadromous fish.

The definitive flora of the area by Calder & Taylor (1968) includes a distinction of salt marshes on the basis of high or low salinity. Marshes of high salinity are fronted by shingle beaches or mudflats which allow the marsh to be flooded by each tidal change. In the lower areas of the marsh, which are broken by a lattice of drainage courses and pools, *Ruppia maritima* often occupies the higher elevations and *Zostera marina* dominates at the lower elevations. In the frontal marsh zone, at the edge of the shoreline, *Deschampsia caespitosa*, *Hordeum brachyantherum*, *Festuca rubra*, *Agrostis exarata*, *Carex lyngbyei*, *Plantago macrocarpa*, *Stellaria hemifusa*, *Triglochin maritimum* and *Trifolium wormskjoldii* predominate. The border of the closed forest adjacent to the marsh is home to additional higher elevation species such as *Apargidium boreale*, *Carex pluriflora*, *Galium trifidum*, *and Calamagrostis nutkaensis* . The high salinity marsh is characterized by a low number of species and a distinct uniformity. *Aster subspicatus* and *Grindelia integrifolia* are found occasionally. Of the low salinity marshes on the Queen Charlotte Islands, the most extensive are those near the mouths of rivers emptying into Masset Inlet. The network of drainage courses originates in the high saltmarsh meadows (where fresh water dilutes the tidal flood) and ends in a wide area of tidal mud flat. The bottoms of the drainage channels are populated by *Ruppia maritima* and occasionally *Zostera marina*, and the borders are occupied by *Triglochin maritimum*, *Puccinellia pumila*, *Lilaeopsis occidentalis* and *Scirpus cernuus* . Between the drainage channels, on the terraces, a mixture of grasses and sedges is common. Back of the lower marsh area, *Agrostis exarata* , *Hordeum brachyantherum*, *Glyceria occidentalis*, *Carex obnupta*, *Juncus arcticus* ssp. *ater* , *Carex canescens* ssp. *arctaeformis*, *Stellaria humifusa*, *Potentilla pacifica* , *Plantago macrocarpa* and *Apargidium boreale* can be found. The area bordering the forest commonly contains *Calamagrostis nutkaensis*, *Bromus pacificus*, *Elymus hirsutus*, *Agrostis palustrus*, *Carex pluriflora*, *Galium trifidum*, *Aster subspicatus* and *Ranunculus orthorhynchus* . Scattered trees of *Pyrus fusca* may occupy the upper reaches of the marsh, and *Alnus* spp. and *Salix* spp. may border the main watercourses. The species richness is typically greater for the low salinity marshes than it is for the high salinity marshes.

In their comparison of an estuarine marsh on Graham Island with one on the adjacent mainland, Campbell & Bradfield (1988) list 27 plants as occurring in four communities (from low marsh to high marsh) on the 105 hectare Yakoun marsh, a *Deschampsia caespitosa* type (Lewis 1982) estuarine salt marsh at the mouth of the Yakoun River on Massett Inlet. The Yakoun marsh falls into the low salinity salt marsh classification of Calder & Taylor (1968).

Percent Frequencies in the Main Plant Communities on the Yakoun Marsh (after Campbell and Bradfield 1988).

Species:	Communities: 1	2	3	4
Deschampsia caespitosa		3	100	82
Carex lyngbyei		100	33	31
Potentilla pacifica			58	44
Glaux maritima	8	10	83	29
Triglochin maritimum	16	35	97	31
Festuca rubra			3	29
Agrostis alba				20
Plantago macrocarpa			8	49
Horedeum brachyantherum			6	24
Juncus balticus			3	100
Aster subspicatus				36
Achillea millefolium				38
Conioselinum pacificum				5
Frutllaria camschatcensis				4
Castilleja sp.				2
Carex pluriflora				2
Dodecatheon pulchellum				2
Plantago maritima		3	50	2
Spergularia canadensis	96	65		
Lilaeopsis occidentalis	8	18	31	2
Puccinellia pumila	8			
Scirpus cernuus	100	88	3	
Ruppia maritima	4	23		
Stellaria hemifusa			31	7
Gallium trifidum				22
Calamagrostis nutkaensis				49
Montia sibirica				20
Carex obnupta				11
Apargidium boreale			14	45
Oenanthe sarmentosa				2
Ranunculus uncinatus				5
Species Richness:	7	9	14	27

While the preceding list represents the flora of an estuary outside the bounds of the proposed national park reserve, an earlier survey of the major salt marsh communities of Windy Bay on Lyell Island (a salt marsh which would fall under Lewis' same *Deschampsia caespitosa* classification) by Inselberg (1979) turned up many of the same species as were found by Campbell & Bradfield (1988) with the addition of the nine species listed below:

Sagina maxima (*crassicaulis*)
- Stick-stemmed Pearlwort
Juncus effusus - Common Rush
Juncus bufonius - Toad Rush
Agrostis exarata - Spike Bentgrass
Vaccinium parvifolium - Red Huckleberry-
Lysichiton americanum - Skunk Cabbage
Vicia americana (questionable)
- American Vetch
Rhytidiadelphus loreus - Lanky Moss
Stokesiella stokesii - Slender Beaked Moss

In their review of the rare vascular plants of British Columbia, Straley, Taylor & Douglas (1985) note only seven rare estuarine plants occurring in the Queen Charlotte Islands. Those plants are as follows:

Calamagrostis crassiglumis
- Thurber's Small Reed Grass
Carex glareosa - Lesser Saltmarsh Sedge
Carex gmelinii - Gmelin's Sedge
Castilleja hyetophila
-Coastal Red Indian Paintbrush
Eleocharis kamtschatica
- Kamtchatka Spike-rush
Ligusticum scoticum - Beach Lovage
Triglochin concinnum
- Graceful Arrow-grass

- Beach Communities

Beaches are found primarily along the north and east coasts of Graham Island, and a few occur on the east coast of Moresby Island. Searing (1987) counted only four sand beaches of appreciable size in the southeast Moresby area, all on Kunghit Island (Luxana Bay, Howe Bay, Woodruff Bay, and Gilbert Bay). The rugged and steeply sloping west coast of Graham Island is essentially devoid of beaches. A few sand beaches can be found on the west coast of Moresby Island. Low rainfall and mild winters on the east coast of Graham Island combine to provide a growing climate characteristic of more southerly latitudes. The east coast of all of the Queen Charlotte Islands provides more habitat diversity than elsewhere in the Islands.

Amongst the beach communities, Calder & Taylor (1968) distinguished two types: shingle beaches and sand beaches. Shingle beaches represent the greater number of beaches found in the Queen Charlotte Islands. They can be further divided into two sub-types: exposed beaches, which are influenced by strong wave action, and protected beaches, which are affected mainly by tidal action.

On the shingle beaches subject to wave action, the loose driftwood zone is sparsely occupied by *Atriplex patula*, *Arenaria peploides*, *Mertensia maritima* and *Cakile edentula*. Amongst the more stable driftwood logs, *Elymus mollis*, *Lathyrus japonicus* and *Vicia gigantea* are found in abundance. On the more stable shingle beaches affected by tidal action alone, the foreshore exhibits a succession of narrow zones beginning with a submerged *Zostera marina* zone and an intertidal zone covered in *Fucus* spp. Above that, in a zone usually inundated by the high tide, *Glaux maritima*, *Salicornia pacifica* and *Triglochin maritimum* predominate. Still higher, in the zone which is only occasionally inundated by the high tide, are the first distinctive greenery of the beach: *Deschampsia caespitosa*, *Carex lyngbyei*, *Festuca Rubra*, *Agrostis exarata* and *Hordeum brachyantherum*. Adjacent to the forest, is an area which is rarely covered except by the highest tides, but which is nonetheless influenced by the salt climate. Species richness is highly variable here, depending on the degree of exposure, but commmon constituents include: *Galium trifidum*, *Ranunculus occidentalis*, *Trifolium wormskjoldii*, *Calamagrostis nutkatensis*, *Melia subulata*, *Fritilaria camschatcensis*, *Poa laxiflora* and *Bromus pacificus*.

Calder & Taylor (1968) subdivided the sand beaches of the Queen Charlotte Islands into two types as well: extensive, continuous beaches such as those fronting McIntyre Bay on Graham Island, and the crescent beaches which have developed between a small number of rocky headlands on both the east and west coasts. Moresby Island does not boast any beaches of the extensive, continuous nature, but there are crescent beaches at the heads of exposed bays. Typically, the vegetative community begins in the shelter of the driftwood, in back of the surf-washed sand crescent on the foreshore. Beach plants may be limited to sparse cover of plants such as *Cakile edentula*, *Lathyrus japonicus* and *Arabis hirstua*. Major plant development begins at the forest margin, which is populated by plants like *Calamagrostis nutkaensis*, *Elymus mollis*, *Gaultheria shallon*, *Vaccinium parvifolium* and *Maianthemum dilatatum*. The more sheltered crescent-shaped sand beaches and those with a transition zone between the band of drift logs and the forest exhibit greater species richness.

Some eight species of vascular plants have been distinguished by Straley, Taylor & Douglas (1985) as rare species of the beaches or dunes in the Queen Charlotte Islands:

Agrostis pallens	-Bent Dune Grass
Amsinckia spectabilis	-Seaside Amsinckia
Atriplex alaskensis	-Alaskan Orache
Carex aernicola	-Sand Dune Sedge
Lathyrus littoralis	-Gray Beach Peavin
Ligusticum scoticum subsp. *hultenii*	-Beach Lovage
Mertensia maritima	-Sea Mertensia
Senecio pseudo-arnica	-Seabeach Ragwort

-Rocky Shore Communities

The majority of the shoreline of the Queen Charlotte Islands is not formed by beaches, but by rocky shore. Calder & Taylor (1968) distinguished two types of rock or cliff communities based on the fact that some of them are more subject to the influence of salt spray than are others. In the communities much influenced by salt spray, the littoral zone is often plentiful in *Phyllospadix scouleri* and little else by way of flowering plants. More species occur above the high tide mark. These include: *Plantago maritima, Sedum rosea, Potentilla villosa, Castilleja unalaschensis, Sagina maxima, Cochlearia oblongifolia, Arenaria peploides, Saxifragia feruginea, Fragaria chiloensis, Fritillaria camtschatcensis, Campanula alaskana, Conioselinum pacificum Draba hyperborea, Lupinus nootkatensis, Achillea millefolium, Barbarea orthoceras* and *Arabis hirsuta* .

On the higher open rock faces, species such as *Fragaria chiloensis, Castilleja unalaschensis, Fritillaria camtschatcensis* and *Saxifraga ferruginea* are more plentiful. The higher community is far more stable than the lower one and is quite unlike the beach flora except in the fact that it adjoins rocky exposures. As a rule, too, the drier eastern coast supports a more diverse community than does the wet west coast.

Rocky islets supporting bird rookeries represent a special case in that the soil is highly nitrified and the habitat is subject to moderately heavy salt spray. The littoral zone is typically well-covered in *Phyllospadix* and *Fucus* , and the cracks and creases in the rock support a scattering of *Plantago maritima, Cochlearia officinalis, Arenaria peploides, Sedum rosea, Angelica lucida, Conioselineum pacificum* and *Draba hyperborea* . A dense herbaceous mix characterizes the summit of such islets. The higher spray-drenched community includes not only the species of the runnels and crevices, but *Matricaria matricarioidies, Mimulus guttatus ssp. guttatus, Juncus arcticus, Agrostis exarata, Sagina maxima, Plantago major, Puccinellia* spp., and occasionally *Rumex transitorius, Deschampsia elongata, Trisetum cernuum, Saxifraga ferruginea* and *Stellaria crispa* as well.

a) RESOURCE ANALYSIS

The stability and productivity of many littoral communities are dependent on macroalgae to reduce wave and current action (Anon. 1983a). As well as hosting epiphytic and parasitic plants, benthic macrophytes serve as nursery areas for marine invertebrates and as spawning grounds for some fish, notably herring. As a food source, live algae are grazed by animals such as sea urchins and abalone,while dead algae feeds detritivores as it recycles nutrients. Even the gametophytes of marine algae are grazed by zooplankton.

By their highly productive nature (producing 300-600 grams dry weight per square metre per year, exlusive of roots) seagrasses are ecologically important to the nearshore community (Wood et al. 1969). Not only do they reduce sediment transport, but they are hosts to some epiphytes and their grazers. The live plant acts as a food source for many animals, and the detritus forms the base of some food webs (Anon. 1983a).

The growth of microscopic algae in nearshore waters influences both water temperature and turbidity. Phytoplanktonic blooms are not unusual in the warmer months of the year, and the biologiacal activity serves to further warm the water, with consequences for all of the other inhabitants. A red algal bloom is often,though not always, associated with an algal bloom of the genus Gonyaulax . It is that organism which causes Paralytic Shellfish Poisoning, commonly known as "red tide" after the colour imparted to the water by the red alga.

Salt marsh vegetation provides an essential base to the estuarine food web through a net annual primary production which is one of the highest (3000 grams per square metre) of any major ecosystem (Simmons 1981). They are the critical habitat for a number of fish, birds and mammals (Campbell & Bradfield 1988). Salt marshes are particularly important for the estimated one million ducks overwintering along the British Columbia coast and for the half of the 10.8 million waterfowl of the Pacific Flyway which use coastal routes (Burgess 1971).

Management Concerns

One has only to look at a topographic map of the Queen Charlotte Islands to realize that the majority of human impact in the proposed national park reserve will be in the foreshore area. Not only must the foreshore be best inventoried and monitored in order to protect the vegetative resource from the ravages of use, but that area must be best understood by the managers of the reserve in order to educate the visiting public.

Macroalgae face the potential threat of harvest by man. The kelp resource is of interest commercially for two reasons: the production of kelp meal, and the harvest of herring spawn on fronds of Macrocystis spp. Interest in the harvest of kelp beds in the Queen Charlotte Islands began as early as 1966 with the establishment of licences to North Pacific Marine Products Ltd. which built a kelp processing plant at Masset (Coon et al. 1979). Various companies have endeavoured to make a viable operation out of it since then with no lasting success. A proposal to build a new kelp processing plant for the region in either Masset or Prince Rupert estimated the volume of harvestable kelp in the Masset area to be 8,200 metric tonnes (Anon. 1980). As of August 1987, there were only 28 roe-on-kelp (gow) fishery permits issued for the whole of the British Columbia coast, of which 14 were for the Queen Charlotte Islands (Searing 1987). Approximately 80 percent of the fishing is done in the Burnaby Island area, within the area of the proposed national marine park reserve.

Along with the mainland and Vancouver Island, the Queen Charlotte Islands constitute one of the three major areas of Pacific coastal salt marshes (Glooschenko et al. 1988). The coastal wetlands of the Queen Charlotte Islands become all the more important when one considers the effect that dyking, log storage, landfill, dredging and pollution have had on the small percentage of the British Columbia coastline made up of salt marshes. And salt marshes may face a new threat from resource extractors encouraged by the possibility of marketing pickleweed (Salicornia virginica) as a vegetable green.

While the vegetation of beaches and rocky shores does not face a threat of resource extraction per se, the removal of drift logs from the shoreline has the potential to change the nature of a beach community, and both coastal habitats are subject to depredation by oil pollution.

- Status of Knowledge

The mapping of marine vegetation has been sporadic both temporally and spatially, particularly in the case of algal beds. While remote sensing techniques may enable researchers to fill data gaps regarding plankton and emerging or floating vegetation, agitation and turbidity of the water pose limitations for the application of the technique to submerged vegetation (Lessard et al. 1987). Community composition has been studied on a regional basis (Searing 1987; Searing & English 1983). The algal flora is well described, largely through the work of Robert Scagel and his colleagues (Scagel 1963; Scagel 1967; Scagel 1970; Hawkes et al. 1978; Lindstrom & Scagel 1979; Garbary et al. 1980).

The coastal salt marshes of the Queen Charlotte Islands are catalogued (Searing 1987; Hunter et al. 1985; Lewis 1982)), but few are inventoried. Species distributions are better documented (Adkins 1977; Garbary et al. 1980; Calder & Taylor 1968). Synecological information is sparse as yet (Campbell 1986; Campbell & Bradfield 1988).

b) SELECT REFERENCE SOURCES

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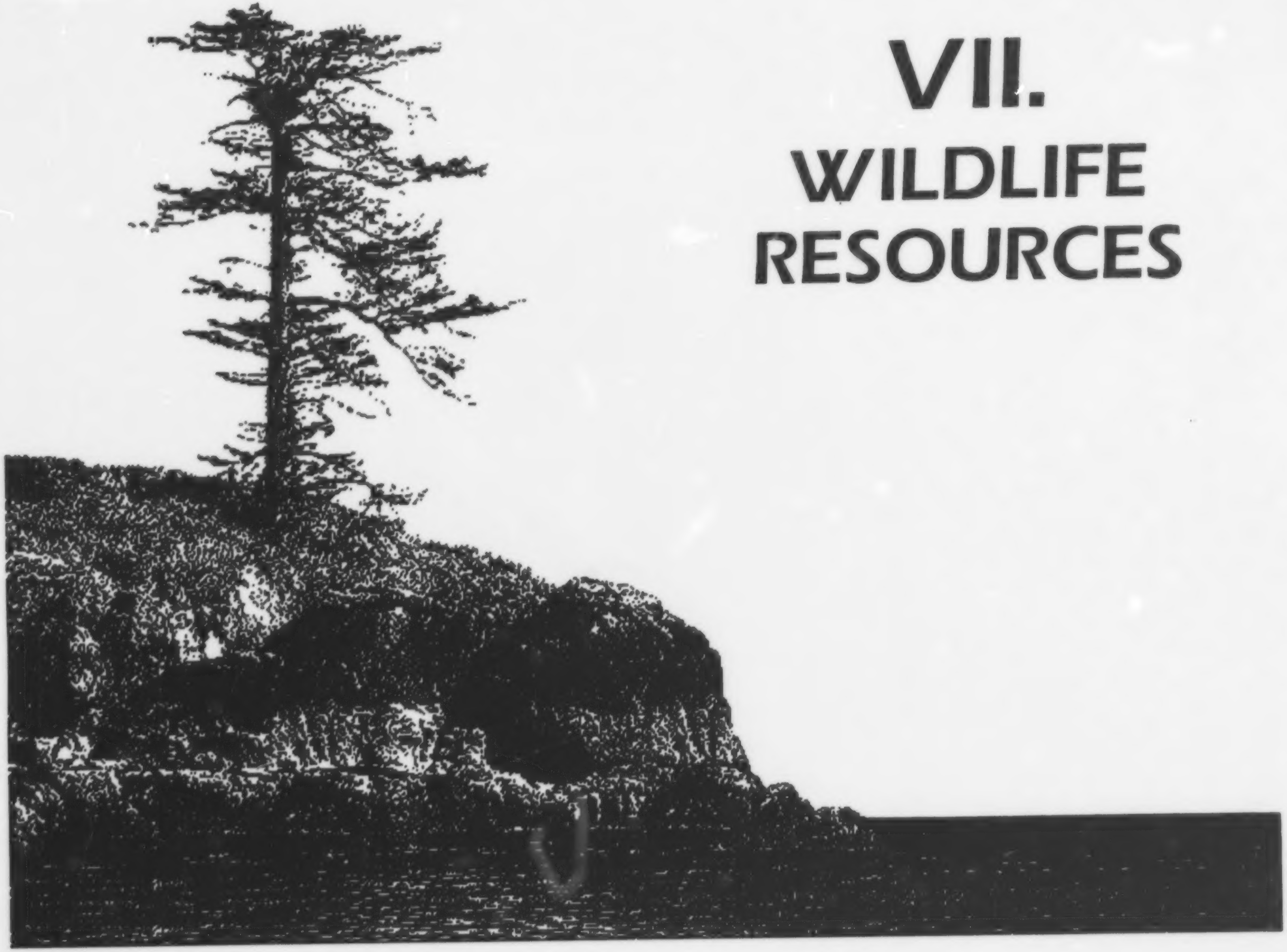
VII.
WILDLIFE RESOURCES



WILDLIFE RESOURCES

General Overview

Not unlike the overview provided for the vegetation resources of the Queen Charlotte Islands, the presence and distribution of the wildlife resources is also the result of a very long process of development influenced by past and present environmental factors, not least of which include the biogeographical island isolation from the mainland populations. Also, just as Walter (1973) designated the Queen Charlotte Islands to be floristically part of the terrestrial Holarctic Realm, Udvardy (1975) designated its faunistic terrestrial counterpart to be part of the *Nearctic Biogeographic Realm*. That then provided the framework which zoologists and zoogeographers employed to classify distinct faunal features and their indicator species as subdivisions of zoogeographic entities; *i.e.* , biogeographical provinces.

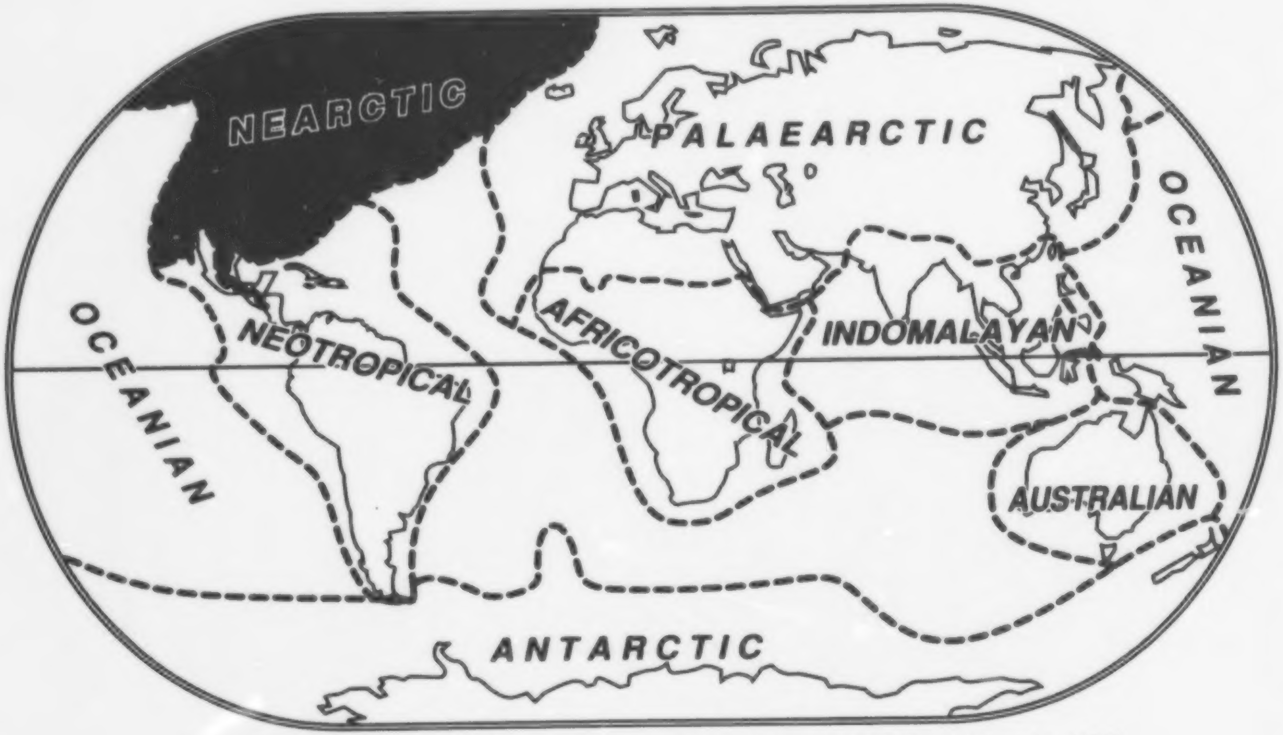
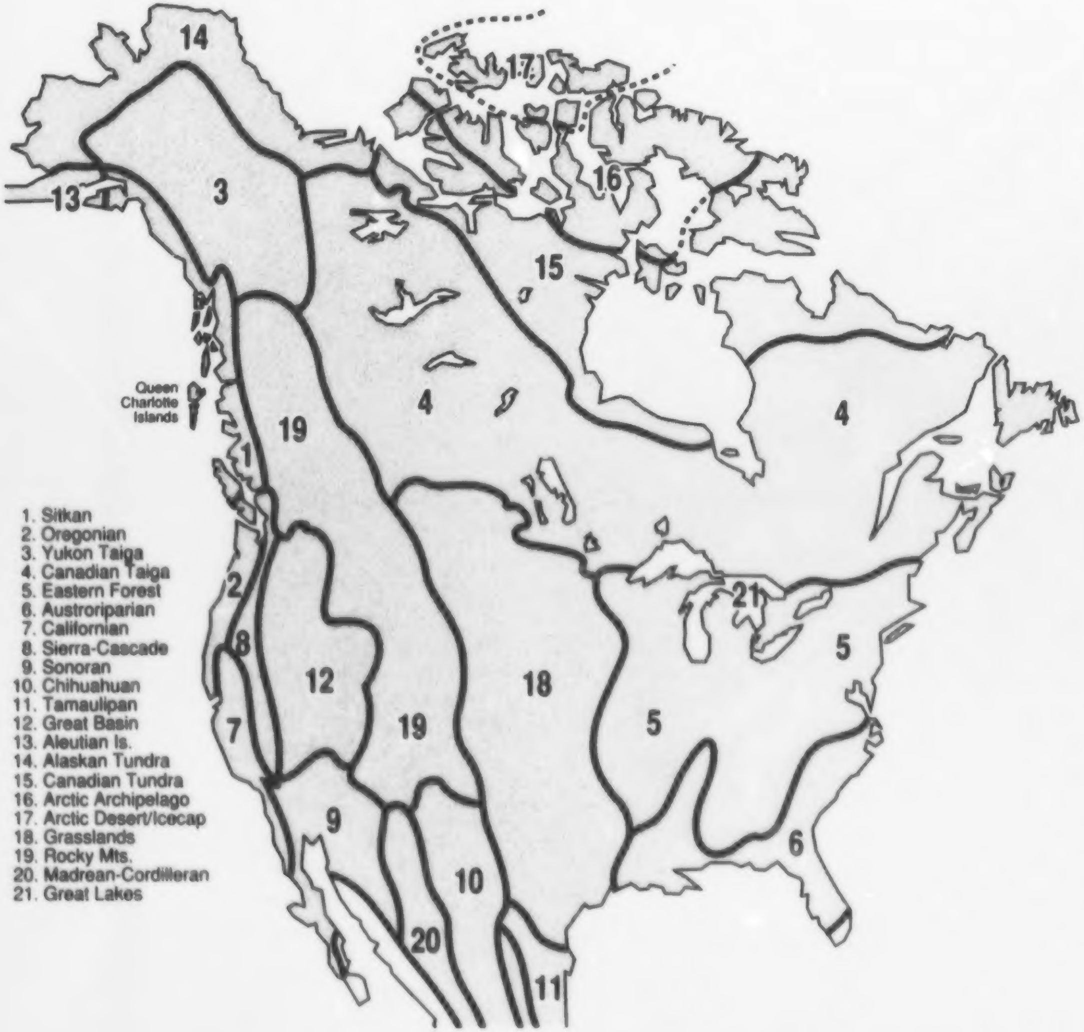

NEARCTIC
PALAEARCTIC
OCEANIAN
NEOTROPICAL
AFRICOTROPICAL
INDOMALAYAN
OCEANIAN
AUSTRALIAN
ANTARCTIC

Figure 136. Terrestrial biogeographic realms of the world (after Udvardy 1975)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Queen Charlotte Islands
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1. Sitkan
2. Oregonian
3. Yukon Taiga
4. Canadian Taiga
5. Eastern Forest
6. Austroriparian
7. Californian
8. Sierra-Cascade
9. Sonoran
10. Chihuahuan
11. Tamaulipan
12. Great Basin
13. Aleutian Is.
14. Alaskan Tundra
15. Canadian Tundra
16. Arctic Archipelago
17. Arctic Desert/Icecap
18. Grasslands
19. Rocky Mts.
20. Madrean-Cordilleran
21. Great Lakes

Figure 137. Biogeographical provinces of the nearctic realm (after Udvardy 1975)

Thus the Nearctic Realm has been further subdivided into twenty-one separate biogeographic provinces, each giving expression to distinct faunistic representations. In keeping with Udvardy's (1975) provinces, the Queen Charlotte Islands are island representatives of the *Sitkan Biogeographic Province* which consists predominantly of a relatively narrow coastal belt along the west coast of North America from just north of the 49th Parallel to near Anchorage, Alaska. Unfortunately, there is no evidence that zoogeographers have followed the path chosen by botanists and foresters; that is, of classifying the fauna of the Islands into smaller and more descriptive ecological categories at the 'biogeoclimatic' or 'ecosite' levels.

In fact, the fascination of the few terrestrial zoologists who undertook faunal studies or descriptions (Foster 1963, 1965; Cowan & Guiguet 1965; Cowan, 1989) with insular isolation and the hypothetical presence of one or more refugia on the Queen Charlotte Islands caused them, perhaps, to select the more thematic approach of study and description in lieu of an integrated, ecological one. The apparent result of that selection has been that, while the few endemic and introduced wildlife species have been well described, information on their population sizes, distributions, habitat descriptions, and especially their ecological inter-relationships, is sadly lacking. In short, no ecological (biophysical) classification scheme has as yet been applied to the terrestrial, or for that matter marine, wildlife resources of the South Moresby/Gwaii Haanas National Park Reserve, nor the Queen Charlotte Islands as a whole.

A. TERRESTRIAL WILDLIFE RESOURCES

In his treatise of the birds and mammals of the Queen Charlotte Islands, Cowan (1989) is the first researcher to present a chronological listing of the individuals who since the turn of the century studied and reported upon the fauna of the Islands. Following is a capsulated version of his listing:

W.H. Osgood, 1901.
Conducted field work during the summer of 1900, and was the first person to provide a general account of the birds and mammals of the Islands.

A. Brooks, W. Spreadborough, R.A. Cumming, G. Darcus, J. A. Munro, R. McD. Stewart, 1901 -1941.
All researchers conducted individual expeditions to the Islands or parts thereof to study birds and animals during these 40 years.

C.J. Guiguet, 1946.
Collected birds and animals on the Islands.

C.J. Guiguet & I. McT. Cowan, 1947.
Collected birds and animals on the Islands.

J.B. Foster, 1963 - 1965.
This naturalist and biologist studied and collected on the Islands, and provided an account of endemism and certain endemic species there, as well as proposing the past existence of one or more refugia.

To date, Foster (1963, 1965) has been the first scientist to present his research findings on the evolution of the mammal fauna of the Queen Charlotte Islands. His works point out that while the fauna of the Islands is indeed in a typical impoverished state, (that is, in relation to the fauna of the mainland to the east), the reasons for that state remain unclear. He makes the point that some mainland species may not have reached the Islands, while others may have reached them, but were not able to adapt or compete and have subsequently been extirpated or become extinct; as, for instance, was the case with the Dawson caribou (*Rangifer dawsoni*). Because of the lack of fossil evidence within the geological history of the area, Foster (1965) confined his remarks to the period from the Vashon Stade (circa 15 ka) to the present. Cowan (1989) on the other hand, postulates:

Thus the non-volant vertebrates of the Queen Charlotte Islands may be survivors of pre-Fraser species that reached the island much earlier by land bridge or by over-water transport; they may be recent arrivals via raft transport; they may have arrived accidentally or inadvertently via the canoes of the Haida or precursor people who occupied the islands in large numbers as far back as 8500 BP. Several species have been introduced by man during the last 50 years. - It is probable that many species of land birds and all the bats first reached the islands as wind driven waifs or as deviant migrants and continue to do so.

The same author notes a number of other ecological anomalies such as:

- the lack of genera associated with alpine habitats;
- the lack of mink in contrast to the presence of marten and ermine;
- the lack of native deer species, and the extinction of the native caribou.

Cowan (1989) draws further attention to the fact that the assemblage of faunal groups appeared to be out of balance with the expected norm. In other words, there is only a total of eleven terrestrial and semi-aquatic mammal species indigenous to the Islands, and four of these are bats. Furthermore, while there are five genera of carnivores, only one rodent genus (*Peromyscus maniculatus*) is present. No squirrels (*Tamiasciurus* spp.) nor red-backed voles (*Clethrionomys* spp.) are native to the Islands. Five new genera of land mammals have been introduced since the area was first visited by European explorers and traders. Cowan (1989) defines the indigenous land mammal fauna of the Queen Charlotte Islands to consist of the following animals:

INDIGENOUS LAND MAMMALS

Order:	Family:	Species:
INSECTIVORA	Soricidae	*Sorex monticolus elassodon* Dusky Shrew *Sorex monticolus prevostensis* Dusky Shrew
CHIROPTERA	Vespertilionidae	*Myotis californicus caurinus* California Bat *Myotis keenii keenii* Keen's Bat *Myotis lucifugus alascensis* Little Brown Bat *Lasionycteris noctivagans* Silver-haired Bat
RODENTiA	Cricetidae	*Peromyscus maniculatus keeni* White-footed Deer Mouse *Peromyscus sitkensis prevostensis* Sitka Mouse
CARNIVORA	Ursidae	*Ursus americanus carlottae* American Black Bear
	Mustelidae	*Martes americana nesophila* American marten *Mustela erminea haidarum* Ermine *Lutra canadensis pericylzomae* River Otter *Enhydra lutris* Sea Otter
PINNIPEDIA	Otariidae	*Eumetopias jubata* Northern Sea Lion
	Phocidae	*Phoca vitulina richardi* Harbour Seal
ARTIODACTYLA	Cervidae	*Rangifer tarandus dawsoni* Dawson Caribou (extinct)

MacLAREN PLANSEARCH (Anon. 1988d) re-worked the available wildlife information and developed a checklist of the mammals expected to be found in the South Moresby / Gwaii Haanas National Park Reserve:

Native Terrestrial / Semi-Aquatic Mammals

Sorex monticolus	- Dusky Shrew
Myotis californicus	- California Bat
Myotis lucifugus	- Little Brown Bat
Myotis keeni	- Keen's Bat
Lasionycteris noctivagans	- Silver-haired Bat
Peromyscus maniculatus	- White-footed Deer Mouse
Ursus americanus	- American Black Bear
Martes americana	- American Marten
Mustela erminea	- Ermine
Lutra lutra (candensis)	- River Otter

Introduced Terrestrial / Semi-Aquatic Mammals

Tamiasciurus hudsonicus	- Red Squirrel
Rattus rattus	- Black Rat
Procyon lotor	- Raccoon
Odocoileus hemionus	- Black-tailed Deer
?	- Domestic Goat

In addition to making the statement that the Dawson Caribou has been extinct since the early 1900's, Cowan (1989) provides further enlightenment about the specifics of successful or failed introductions of mammals to the Queen Charlotte Islands; *i.e.*,

Black-tailed Deer
(*Odocoileus hemionus columbianus*).
The species spread quickly across the Islands following their introduction to Graham Island from Porcher Island during the period from 1900 - 1916.

Wapiti
(*Cervus elaphus nelsoni*).
The species was introduced near Lawn Point at an unknown date, after being transhipped from an enclosure at Vancouver. While they have apparently survived there, they have not migrated far from their place of introduction as yet.

European Red Deer
(*Cervus elaphus elaphus*).
A small group from New Zealand were released near Masset in about 1920. They established themselves successfully, but were extirpated through poaching between 1940 and 1944.

Muskrat
(*Ondatra zibethica osoyoosensis*).
The specimens introduced to Graham Island are believed to have originally come from the Fraser River delta near Vancouver. They have since been observed on Langara Island.

Red Squirrel
(*Tamiasciurus hudsonicus lanuginosus*).
Some individuals captured near Campbell River on Vancouver Island were released on Graham Island in 1947. Their introduction was successful, and they have since spread throughout the Islands.

American Beaver
(*Castor canadensis leucodontus*).
Specimens were captured near Campbell River on Vancouver Island and then released near Tlell on Graham Island in 1947. The species was able to establish itself successfully, and has since spread over the northeastern portions of Graham Island, greatly altering the local environment in its progress.

European Roof Rat
(*Rattus rattus*).
The introduction of this species was likely achieved through escapees from ships at Langara, Graham, Moresby, and Kunghit Islands. It is surmised that the species has since spread to other islands in the archipelago.

Raccoon
(*Procyon lotor vancouverensis*).
Believed to have been introduced to Graham Island around 1946. The specimens released were originally captured near Campbell River on Vancouver Island. They have thrived and are now believed to be abundant throughout the Islands.

Furthermore, Cowan (1989) points out that the genera typically associated with alpine habitats, (such as *Lemmus*, *Synaptomys*, *Phenacomys*, *Marmota*, and *Ochotona*), are absent from the Queen Charlotte Islands. Considering this point and the previously made statements that emphasize the peculiar assemblage of wildlife species, Cowan makes the observation that the wildlife assemblage found there, is not one of a "balanced ecosystem".

The avifauna has long been viewed as one of the outstanding natural resources of the Queen Charlotte Island. The marine bird fauna component makes up the largest percentage, both in numbers and general distribution. Cowan (1989) states that seventy-one (71) avifaunal species either nest or are believed to nest on the Islands. Of these, twenty-two (22) are shore or sea birds. Of the remaining species, only forty-two (42) primarily nest and forage away from the sea shore. Cowan draws attention to the fact that the avifauna occupying equivalent habitats on the mainland, consists of at least another twenty-three (23) species that are not represented on the Queen Charlotte Islands. He makes a further point by stating:

> **Thus of a potentially available fauna of 65 species, about 58 percent have successfully migrated to the islands and established themselves there. Especially conspicuous by their absence on the Queen Charlotte Islands are the species characteristic of the alpine and subalpine communities such as the three ptarmigan species, golden eagle, gray jay, mountain chickadee, rosy finch, water pipit and golden-crowned sparrow, even though the habitat is extensive. Of this fauna only the pine grosbeak is present.**

While painstaking observations are believed to have recorded all of the bird species inhabiting the Islands, the situation may still exist that one or more species might either have been overlooked since 1901, or have since migrated to the Islands. Cowan (1989) provides the following, (and believed to be current), listing of indigenous breeding birds:

INDIGENOUS BREEDING BIRDS

Order:	Family:	Species:	Common Names:
CICONIIFORMES	Ardeidae	*Ardea herodias*	Great Blue Heron
ANSERIFORMES	Anatidae	*Branta canadensis*	Canada Goose
		Anas discors	Blue-winged Teal
FALCONIFORMES	Accipitridae	*Accipiter gentilis*	Goshawk
		Accipiter striatus	Sharp-shinned Hawk
		Buteo jamaicensis	Red-tailed Hawk
	Falconidae	*Falco peregrinus*	Peregrine Falcon
GALLIFORMES	Phasianidae	*Dendragapus obscurus*	Blue Grouse
GRUIFORMES	Gruidae	*Grus canadensis*	Sandhill Crane
CHARADRIIFORMES	Charadriidae	*Charadrius semipalmatus*	Semipalmated Plover
		Charadrius vociferus	Killdeer
	Haematopodidae	*Haematopus bachmani*	Black Oystercatcher
	Scolopacidae	*Gallinago gallinago*	Common Snipe
		Actitis macularia	Spotted Sandpiper
		Calidris minutilla	Least Sandpiper
		Limnodromus griseus	Short-billed Dowitcher
	Laridae	*Larus glaucescens*	Glaucous-winged Gull
	Alcidae	*Uria aalge*	Common Murre
		Uria lomvia	Thick-billed Murre
		Cepphus columba	Pigeon Guillemot
		Fratercula corniculata	Horned Puffin
		Fratercula cirrhata	Tufted Puffin
		Cerorhinca monocerata	Rhinoceros Auklet
		Ptychoramphus aleuticus	Cassin's Auklet
		Brachyramphus marmoratum	Marbled Murrelet
		Synthliboramphus antiquus	Ancient Murelet
STRIGIFORMES	Strigidae	*Aegolius acadicus*	Northern Saw-whet Owl
APODIFORMES	Trochilidae	*Selasophorus rufus*	Rufous Hummingbird

INDIGENOUS BREEDING BIRDS (continued)

Order:	Family:	Species:	
CORACIIFORMES	Alcedinidae	*Ceryle alcyon*	Belted Kingfisher
PICIFORMES	Picidae	*Colaptes auratus*	Northern Flicker
		Sphyrapicus ruber	Red-breasted Sapsucker
		Picoides villosus	Hairy Woodpecker
PASSERIFORMES	Tyrannidae	*Empidonax difficilis*	Western Flycatcher
		Contopus sordidulus	Western Wood-Pewee
	Hirundinidae	*Hirundo rustica*	Barn Swallow
		Tachycineta thalassina	Violet-green Swallow
		Tachycineta bicolor	Tree Swallow
	Corvidae	*Cyanocitta stelleri*	Steller's Jay
		Corvus corax	Common Raven
		Corvus caurinus	Northwestern Crow
	Paridae	*Parus rufescens*	Chestnut-backed Chickadee
	Sittidae	*Sitta canadensis*	Red-breasted Nuthatch
	Troglodytidae	*Troglodytes troglodytes*	Winter Wren
	Cinclidae	*Cinclus mexicanus*	American Dipper
	Muscicapidae	*Regulus satrapa*	Golden-crowned Kinglet
		Turdus migratorius	American Robin
		Ixoreus naevius	Varied Thrush
		Catharus guttatus	Hermit Thrush
		Catharus ustulatus	Swainson's Thrush
	Emberizidae	*Vermivora celata*	Orange-crowned Warbler
		Dendroica townsendi	Townsend's Warbler
		Wilsonia pusilla	Wilson's Warbler
		Junco hyemalis	Dark-eyed Junco
		Passerella iliaca	Fox Sparrow
		Melospiza melodia	Song Sparrow
		Melospiza lincolni	Lincoln's Sparrow
	Sturnidae	*Sturnus vulgaris*	European Starling*
	Fringillidae	*Pinicola enucleator*	Pine Grosbeak
		Carduelis pinus	Pine Siskin
		Loxia curvirostra	Red Crossbill

(* this species was added to Cowan's listing by the authors)

It has also been established that the activities of raccoons, rats, and possibly other introduced mammalian species, have not only altered significant aspects of the natural terrestrial environment of the Queen Charlotte Islands, but more specifically, have seriously impacted the breeding habitats of several avifaunal species (refer to the "Marine Wildlife Resources" section).

The provincially sponsored South Moresby Resource Planning Team (Anon. 1983b) estimated that more than one hundred streams within the national park reserve supported stocks of salmon species. In addition, it has been established that rainbow trout (*Oncorhynchas mykiss*), Dolly Varden char (*Salvelinus malma*), and coast range sculpin (*Cottus aleuticus*) occur in many of the streams. The same team sampled 183 lakes throughout the Queen Charlotte Islands and reported that only seven species of fish were found to inhabit them (Anon. 1988d); *i.e.*:

- Threespine stickleback
  Gasterosteus aculeatus
  at 86 sample sites;
- Dolly Varden char
  Salvelinus malma
  at 37 sample sites;
- Coho salmon
  Oncorhynchus kisutch
  at 22 sample sites;
- Cutthroat trout
  Oncorhynchus clarki
  at 18 sample sites;
- Prickly sculpin
  Cottus asper
  at 17 sample sites;
- Rainbow trout
  Oncorhynchus mykiss
  at 13 sample sites;
- Coast range sculpin
  Cottus aleuticus
  at 2 sample sites.

Furthermore, the federal Department of Fisheries and Oceans (Anon. 1988d) determined that a number of streams on Moresby Island supported small runs of coho salmon (*Oncorhynchus kisutch*). Also, some kokanee (*Oncorhynchus nerka*), sockeye salmon (*Oncorhynchus nerka*, anadromous form), chum salmon (*Oncorhynchus keta*), pink salmon (*Oncorhynchus gorbusha*), and brook lamprey (*Lampetra ayresi*) may on occasion occur in some of the lakes (Anon. 1988d).

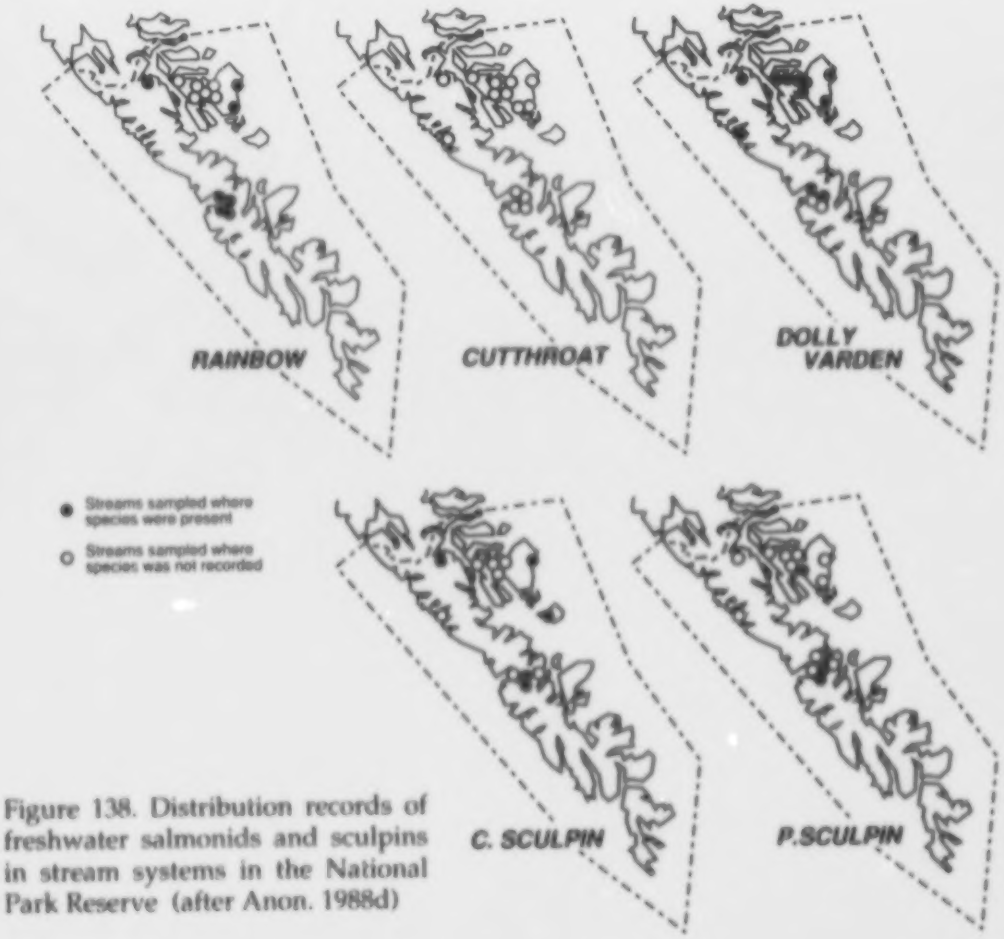
RAINBOW
CUTTHROAT
DOLLY VARDEN
● Streams sampled where species were present
○ Streams sampled where species was not recorded
C. SCULPIN
P.SCULPIN

Figure 138. Distribution records of freshwater salmonids and sculpins in stream systems in the National Park Reserve (after Anon. 1988d)

The information base about reptiles and amphibians of the Queen Charlotte Islands consists of but a few confirmed records (Anon. 1988d), some of which are suppositions, and must be regarded as incomplete. Carl (1959) has established that the western toad (*Bufo boreas*) occurred on the Islands as an endemic species. The Pacific tree frog (*Hyla regilla*) was apparently introduced to Graham Island some years ago and has adapted to its new habitat so well that it may already have extended its range to include Moresby Island (Foster 1984). More recently, occasional sightings of a reddish-brown salamander have been reported on Graham Island, but to date no photographs or specimen have been obtained to confirm the sightings (Anon. 1989b).

The available literature regarding the terrestrial invertebrates of the Queen Charlotte Islands is limited to some general guides and species lists for the coastal areas of British Columbia and certain studies specific to moth species and blackflies. Perhaps the most definitive invertebrate study to date is that of Kavanaugh (1989), who investigated the carabid beetle fauna of the Queen Charlotte Islands and during that study visited the western and southern portions of Moresby Island, including Louise, Lyell, Burnaby, and Khungit Islands. A total of 59 species of carabid beetles are now known to occur on the Queen Charlotte Islands.

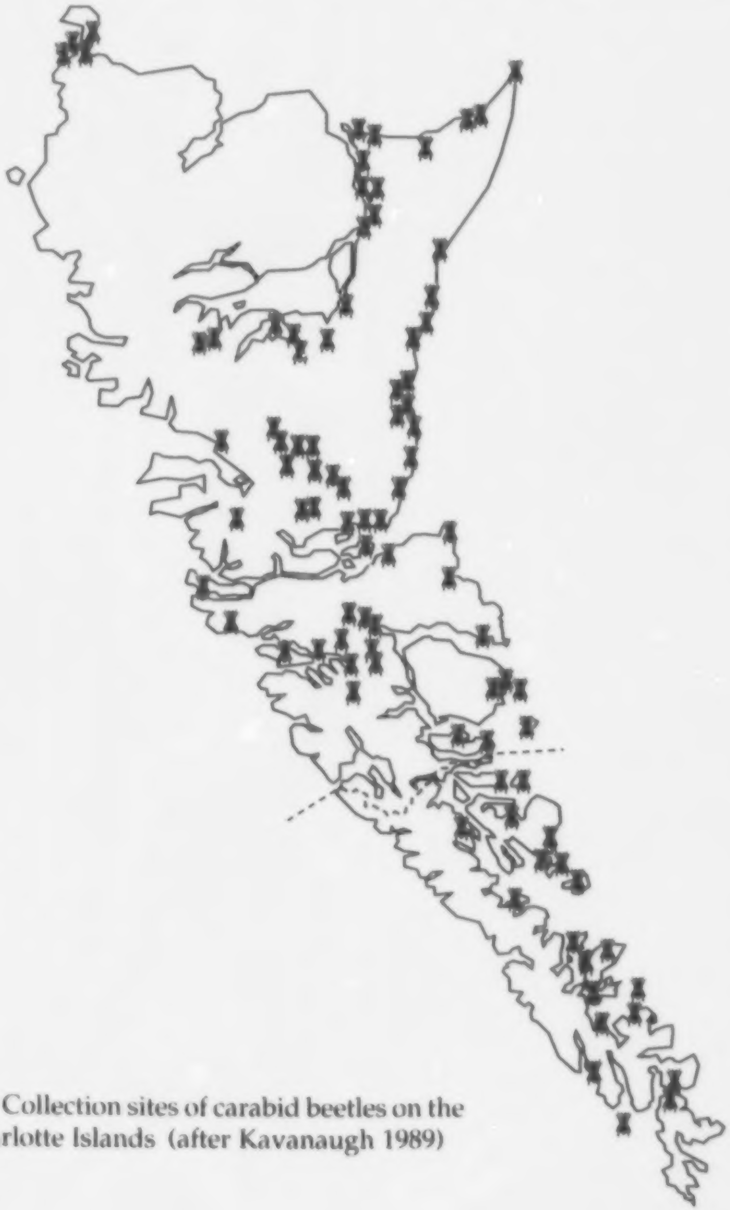

Figure 139. Collection sites of carabid beetles on the Queen Charlotte Islands (after Kavanaugh 1989)

a) RESOURCE ANALYSIS

While there exists a good description and a fair understanding of the general number of terrestrial wildlife species now thought to be present and distributed across the Queen Charlotte Islands, it is not at all certain that all species actually present have been accounted for. This statement holds particularly true for the South Moresby / Gwaii Haanas National Park Reserve, for which there is very little site-specific information of any kind.

For instance, no information has been noted in the literature perused about the actual population sizes and the distribution of the mammalian and avifaunal species said to occur within the national park reserve. Likewise, information about reptile, amphibian, and invertebrate faunas, where existent at all, is very scarce and of even less site-specific value. In most instances, the available information base is so scarce in factual descriptions that it does not allow intelligent inferences to be made readily. The only topic for which more site-specific information has been rapidly gathering recently is that of the type and extent of predation by certain introduced mammalian species, i.e., the raccoon and the black rat, on the colonies of shore-nesting seabird species.

On the other hand, while it is quite obvious to even the casual observer how extensive the cumulative ecological damage actually is that the apparently large numbers of introduced black-tailed deer (Odocoileus hemionus columbianus) *have caused on South Moresby Island, no research appears to have been conducted to date either on the population dynamics of the species or on the vegetation damage that it is causing. It is also surprising that the presence of domestic goat on some of the islands has not aroused any factual environmental concerns that are documented.*

The fisheries resources of lakes and streams have enjoyed some academic and possibly commercial attention in recent years; but again, the information now available is either very site-specific to streams outside of the national park reserve, or too broad where it pertains to the reserve. Much more detailed work will be required to fully appreciate the terrestrial fishery resources of the South Moresby / Gwaii Haanas National Park Reserve.

Finally, several species of terrestrial birds that are considered to be "endangered" in other parts of Canada, are commonly found along the Pacific coast of the Queen Charlotte Islands. Among them are species like the peregrine falcon (Falco peregrinus), *bald eagle* (Haliaeetus leucocephalus), *trumpeter swan* (Olor buccinator), *and the sandhill crane* (Grus canadensis). *The status of the individual populations and their distributions throughout the South Moresby / Gwaii Haanas National Park Reserve requires to be ascertained.*

- Management Concerns

The overriding management concern relates directly to the lack of an in-depth "ecological land classification" type of inventory conducted in a multi-disciplinary and fully integrated methodology, either for its own sake, or directly connected to an all-inclusive limnological inventory of equal scale. Such an inventory would provide the biological and physical information necessary to commence the management of the wildlife resources of the national park reserve in an ecologically integrated manner.

The incomplete status of the terrestrial wildlife data base demands that a conservative and protective management stance be employed until a complete inventory has been conducted. Only then ought any park uses and angling exploitations by park visitors be considered. However, until that enlightened state is attained, resource managers need, through discussion with provincial and federal counterparts and select representatives of the academic community, to become fully informed about those introduced mammalian species that have been observed to be clearly destructive to endemic plant and animal species. Such an approach would serve to provide the time and knowledge required to develop resource management solutions to the existing anomalous situations.

- Status of Knowledge

As demonstrated in the description of the terrestrial resources and reiterated in the above resource analysis, the current status of knowledge about the terrestrial wildlife is not sufficient for park management purposes. What is now known about wildlife within the South Moresby / Gwaii Haanas National Park Reserve does not allow extrapolations to be made which could provide ecologically sound assurances that the various forms of park development likely to take place would not negatively impact parts or all of the wildlife resources.

The Interim Management Guidelines for the reserve have taken the currently weak status of knowledge into account, and provide for a cautious, conservative approach to all manners of terrestrial wildlife management.

b) SELECT REFERENCE SOURCES

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Birds and Mammals on the Queen Charlotte Islands. IN: G.G.E. Scudder and N. Gessler, eds. The Queen Charlotte Islands International Symposium, July 1984, Vancouver, British Columbia. pp. 175-186.

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A Classification of the Biogeographical Provinces of the World. IUCN Occasional Paper No. 18, Man and the Biosphere Programme Project No. 8, International Union for Conservation of Nature and Natural Resources, Morges, Switzerland. 18p.

B. MARINE WILDLIFE RESOURCES

The description of the marine wildlife resources of the Queen Charlotte Islands is at once simpler and more complex than that for the terrestrial wildlife resources. Simpler, because there is no question of there having been or not having been a glacial refugium. And more complex in that there are far more species (indeed, far more genera) represented than is the case for the terrestrial fauna. While Ian McTaggart Cowan (1989) is well justified in describing the terrestrial mammalian population of the Queen Charlotte Islands as depauperate, the same could not be said of the marine mammalian population. What is more, the ocean by its open nature encourages a large transient population. Given the complexity of the marine faunal population, it is expedient to treat the subject of marine wildlife by dividing the fauna into seven categories: microbiota, zooplankton, benthic invertebrates, fish, herpetiles, birds, and mammals.

-Microbiota

Microbiota include bacteria, fungi and slime molds, of which bacteria are the most important to the marine environment in their role as recycling agents for organic matter (Anon. 1983a). They serve as food for detritivores, filter-feeding organisms, and bottom feeders as well as modifying various marine processes by the products which they produce. A small number of bacteria are oleoclasts, heterotrophic bacteria with the ability to metabolize petroleum. The principal marine bacterial genera include: *Micrococcus, Sarcina, Bacillus, Vibrio, Bacterium, Pseudomonas, Corynebacterium, Spirillum, Micoplana, Nacardia* and *Streptomyces.* Heterotrophic bacteria occur throughout the ocean and sediment layers. Below the level of penetration of dissolved oxygen, anaerobic bacteria replace the aerobic bacteria found above.

While there is no site-specific microbiological data for the northern shelf region of British Columbia, most coastal waters contain 10^5 to 10^7 bacterial cells per millilitre, with similar numbers occurring in the associated sediments (L. Albright, Simon Fraser University, pers. comm. in Anon. 1983a). The productivity of marine bacteria is thought to be on the same order as that of phytoplankton, the range for which is 25 to 70 milligrams of carbon per square metre per day in the winter to 650 milligrams of carbon per square metre per day during the summer (Sorokin 1974).

The cycle of phytoplanktonic production in the northern shelf area which is presented by Dilke *et al.* (1979) and Perry *et al.* (1981) is such that there is a spring bloom in late March or April, with a concomitant increase in numbers and metabolic activity of bacteria likely in April and May in western Hecate Strait, Dixon Entrance and Queen Charlotte Sound (Anon. 1982). The stratification of the water column in most of the area during May and June caused by the input of freshwater and surficial warming (Dodimead 1980) results in a decrease in primary productivity except in areas (such as shoals, inlets and passes) where tidal mixing or estuarine circulation is vigorous enough to cause disruption of the pynocline. Though smaller than the spring peak in bacterial production, there is a second annual peak in October and November when fall storms contribute to more mixing of the water column. Bacterial activity is at a minimum during the winter, though shallow areas and areas which get a continued deposition of organic materials exhibit relatively high levels of bacterial activity (Anon. 1982).

Oleoclastic bacteria (primarily of the genera *Flavobacterium* and *Pseudomonas*, and occasionally of the genera *Acinetobacter* and *Alcaligenes*) are undocumented in the area, though a study by Westlake & Cook (1980) revealed the presence of oleoclastic bacteria in the substrates and sediments of northern Puget Sound and the Strait of Juan de Fuca.

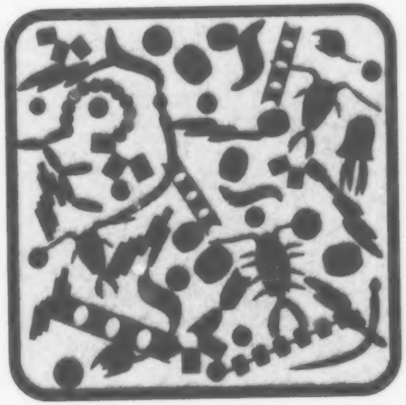
-Zooplankton

For the purposes of this document, zooplankton are considered as holoplankton, which remain planktonic throughout their life; and meroplankton, which are planktonic in their larval stages and benthic in their adult stages. Ichtheoplankton, the larval stage of fishes, will be treated as part of the fish. Holoplankton are an important source of food throughout the year for both fish and ichthyoplankton (Anon. 1982). The meroplankton, which include the larvae of many benthic invertebrates, occur only after reproduction in the spring or early summer (Raymont 1963).

The zooplankton biomass in temperate coastal waters varies season to season much as does phytoplankton biomass (Parsons *et al* . 1977, Dilke *et al.* 1979, Perry *et al.* 1981). The spring zooplankton bloom is about 2 to 4 weeks behind the spring phytoplankton bloom, and there is a second zooplankton bloom following the phytoplankton bloom in the autumn. The zooplankton biomass is smaller during the summer and winter seasons (Parsons *et al.* 1977). Logically, areas such as tidal fronts and estuaries which are high in primary production exhibit higher zooplankton biomass than do stiller waters (Fournier *et al.* 1977, Brodie *et al.* 1978). In terms of spatial distribution, wherever they occur, zooplankton exhibit a horizontal patchiness which is related to the fact that most zooplankton make diurnal vertical migrations through the water column which vary in length from about 400 metres for the smaller species to about 600 metres for the larger species (Barnes & Hughes 1988).

In studying the distribution of copepod species in the area of the Queen Charlotte Islands, Cameron (1957) identified 32 species. She attributed their distribution to currents, and was able to associate reproduction of copepods with specific temperature and salinity regimes. North of Masset Inlet, *Paracalanus parvus* was found in water with temperatures greater than 10° C. In Masset Inlet and northwest of Graham Island, *Acartia clausii* was common in warm, relatively fresh water. In Dixon Entrance, near the 100 metre contour, Cameron (1957) identified the deepwater species *Metridia lucens*.

An atlas of zooplankton standing stocks in the northeastern Pacific Ocean was compiled by LeBrasseur in 1965 based on samples taken during the Oceanographic Survey Programme between 1956 and 1964. Total weights were estimated by taxonomic group and mapped. For Dixon Entrance, the total estimated zooplankton biomass was 181 mg/m^3, of which 163 mg/m^3 were copepods, 9 mg/m^3 were chaetognaths and 5 mg/m^3 were euphausiids. No mapping was done for Dixon Entrance, however, as the sampling density was too low. In reviewing some of the data for Hecate Strait and Queen Charlotte Sound, Parsons (1965) approximated a minimum wet weight of zooplankton in March of 0.4 to 45 mg/m^3 and a maximum wet weight in May of 134 to 246 mg/m^3. Later analysis of LeBrasseur's data by Walters *et al.* (1978) demonstrates the spring maximum noted by Parsons (1965), though no data was collected in October to support the occurrence of a fall zooplanktonic bloom.



A Ship-of-Opportunity programme conducted by the Department of Oceanography at the University of British Columbia sampling near surface zooplankton in the northern shelf area yielded estimates of zooplankton numbers per unit volume (Dilke *et al.* 1979 and Perry *et al*. 1981). Just as LeBrasseur found, zooplankton abundance was found to be low in winter, and copepods dominated. The increased aerial variability in zooplankton abundance in the spring over the winter corresponded to both increased variability in chlorophyll concentration and phytoplankton abundance. Differences in abundance between stations were thought to be attributable to differences in chlorophyll concentration and phytoplankton abundance. Investigations by Gardner (1980, 1982a,b) of associations between zooplankton species and water characteristics further support the notion that zooplankton distribution in British Columbia's northern shelf region correlates with the distribution of phytoplankton production.

It may not be the case, though, that large phytoplankton standing crops correlate with large zooplankton standing crops, as herbivorous zooplankton may graze a productive crop of phytopankton at a rate approaching production (Anon. 1982). So while western Hecate Strait and southeastern Queen Charlotte Sound may not exhibit large standing crops of phytoplankton, their high phytoplankton productivity make them important to zooplankton and thereby to ichthyoplankton and birds which feed in turn on the zooplankton.

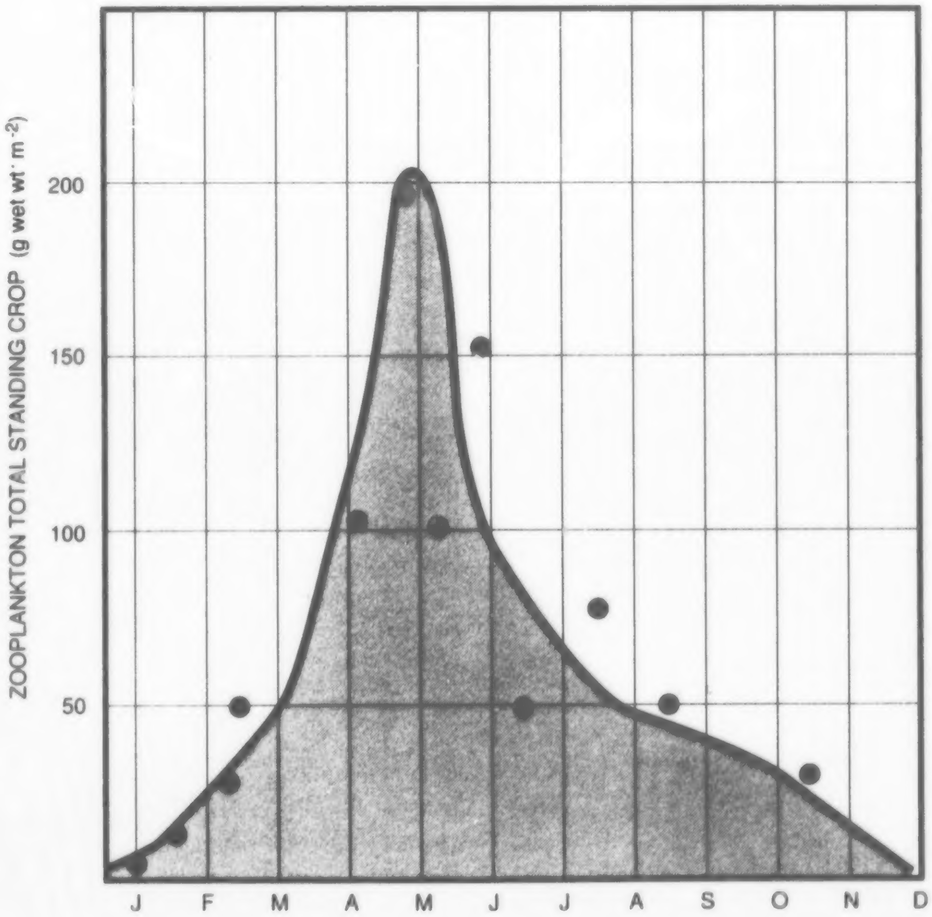


Figure 140. Seasonal zooplankton abundance within 200 km of the northern British Columbia coast (after Walters *et al.* 1978)

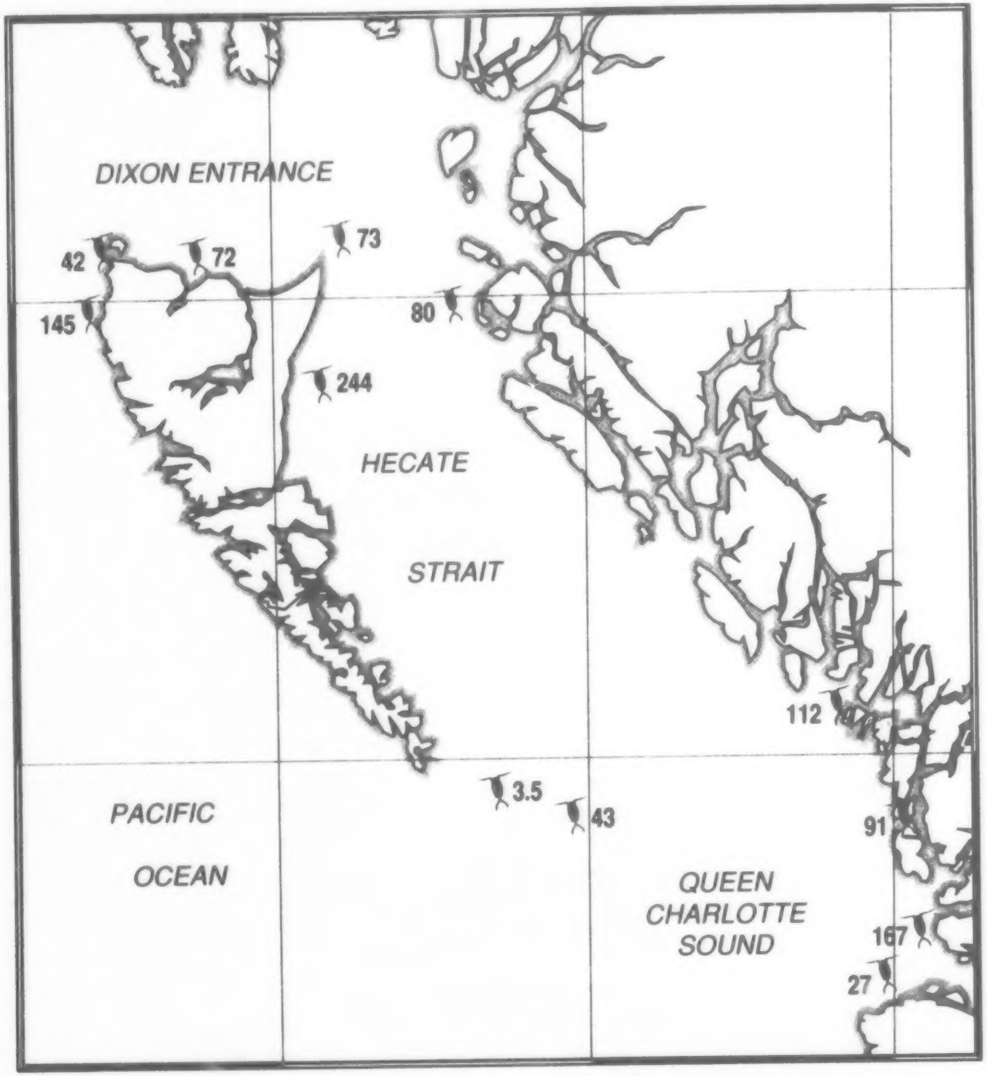


Figure 141. Zooplankton distribution for April, 1980. Numbers indicate total number of zooplankton per cubic millimetre (after Perry *et al.* 1981)

In their study of tidal mixing and summer plankton distributions in Hecate Strait, Perry *et al.* (1983) found that the copepods of the northern strait were dominated by *Centropages* species and *Acartia longiremis.* Of the non-copepod zooplankton, brachyuran crab larvae were important in the western strait, and barnacle nauplii were important in the eastern strait.

Commenting on the zooplankton results of the Canadian Pacific Coast ichtyoplankton surveys (Fulton *et al.* 1982), J. Mason of the Department of Fisheries and Oceans (pers. comm. in Anon. 1983a) noted that the copepod *Neocalanus plumchrus* dominated in the winter on the outer Continental shelf and in spring in Hecate Strait and Queen Charlotte Sound, though zooplankton standing stocks were relatively poor, due likely to physical instability and shallow depths.

Since 1975, there has been a small zooplanktonic fishery for euphausiids (small shrimp-like invertebrates) which has been confined to the Strait of Georgia (Bernard 1982).

-Benthic Invertebrates

The echinoderms, molluscs and crustaceans which make up the marine invertebrate resources of British Columbia are essentially creatures of the sea floor environment, though some may move up in the water column to feed. In an otherwise three-dimensional marine environment, the benthic invertebrates exploit a largely two-dimensional habitat, superficially similar to that of their terrestrial counterparts. In so doing, the benthic invertebrates lend themselves to community descriptions based on habitat. The tables which follow describe the littoral benthic fauna of the northeastern Pacific and are based on the work of several authors (Anon. 1976a ; Austin 1970; Austin *et al*. 1971; Bernard 1970; Breen 1979; Cross *et al*. 1978; Gardner 1978; Kozloff 1973; Lee & Bourne 1976, 1977, 1978, 1979; McDaniel 1973; Nyblade 1978; O'Connell 1977; Packman 1979; Packman *et al* 1975; Ricketts & Calvin 1968; Simenstad *et al*. 1979; Smith & Webber 1978) as compiled in two more recent publications (Anon. 1982, Anon. 1983a). The descriptions are not meant to suggest that benthic invertebrates are organized in discrete communities, similar according to substrate and exposure. Communities tend to grade into one another, and the relationship of individual species requirements to localized differences in the marine environment make intermediacy the rule rather than the exception in distinguishing communities (Barnes & Hughes 1988). The zonations which are distinguished below are to be regarded as typical rather than as absolute.

Major Benthic Invertebrates of Bedrock Substrates in the Pacific Northeast (after Anon. 1982 and Anon. 1983a)

EXPOSED INTERTIDAL ZONE

Elevation:	Species:	Scientific Name:
Upper	Barnacle	*Balanus glandula*
	Barnacle	*Chthamalus dalli*
	Limpet	*Collisella digitalis*
	Limpet	*Notocamea persona*
	Periwinkle	*Littorina sitkana*
	Periwinkle	*Littorina scutulata*
Mid	Mussel	*Mytilus californianus*
	Starfish	*Pisaster ochraceus*
	Goose-neck barnacle	*Pollicepes polymerus*
	Polychaete worm	*Nereis vexillosa*
	Chiton	*Katharina tunicata*
	Chitons	*Mopalia* spp.
	Isopods	*Ligia* spp.
	Isopod	*Idotea wosnesenskii*
	Snail	*Thais emarginata*
Lower	Purple urchin	*Strongylocentrotus purpuratus*
	Sponge	*Haliclona* sp.
	Sponges	*Halichondria* spp.
	Starfish	*Leptaserias hexactis*
Surge Channels & Tide Pools	Anemone	*Anthopleura xanthogrammica*
	Anemone	*Anthopleura elegantissima*
	Keyhole limpet	*Diodora aspera*
	Hermit crab	*Pagurus* sp.
	Shore crab	*Hemigrapsus* sp.
	Chitons	various spp.

Major Benthic Invertebrates of Bedrock Substrates in the Pacific Northeast
(after Anon. 1982 and Anon. 1983a)

SEMI-EXPOSED INTERTIDAL ZONE

Elevation:	Species:	Scientific Name:	Species:	Scientific Name:
Upper	(Composition similar to that of the exposed environment)			
Mid	Mussel	*Mytilus edulis*	Starfish	*Leptasterias hexactis*
	Snail	*Thais lamellosa*	Barnacle	*Balanus cariosus*
	Starfish	*Pisaster ochraceus*		
Lower	Crab	*Cancer oregonensis*	Encrusting sponge	*Haliclona permollis*
	Crabs	*Pagurus* spp.		
	Crab	*Hemigrapsus nudus*	Encrusting sponge	*Ophlitaspongia pennata*
	Amphipods	*Amphithoe* spp.		
	Isopod	*Idotea wosnesenskii*	Holothuroid	*Cucumaria miniata*
	Isopod	*Gnorimosphaeroma* sp.	Holothuroid	*Eupentacta quinquesemita*
	Snail	*Searlesia dira*	Bryozoans	various spp.
	Snail	*Lacuna* sp.	Nudibranchs	various spp.
	Chiton	*Mopalia* sp.	Small asteroids	various spp
	Chiton	*Tonicella* sp.		
	Polychaete	*Serpula vermicularis*		
	Polychaete	*Spirorbis* sp.		
	Polychaete	*Eudistylia vancouveri*		
	Polychaete	*Thelepus crispus*		
	Polychaete	*Nereis* sp.		

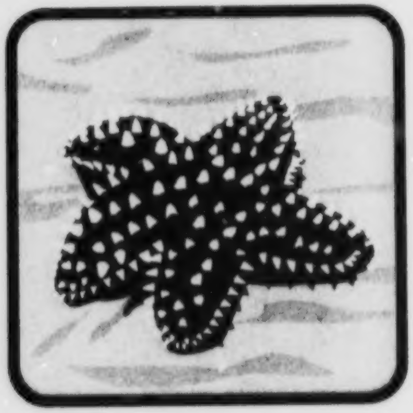
Major Benthic Invertebrates of Bedrock Substrates in the Pacific Northeast
(after Anon. 1982 and Anon. 1983a)

PROTECTED INTERTIDAL ZONE

Elevation:	Species:	Scientific Name:	Species:	Scientific Name:
N/A	Mussel	*Mytilus edulis*	Tunicate	*Cnemidocarpa finmarkiensis*
	Snail	*Thais lamellosa*		
	Starfish	*Pisaster ochraceus*	Snail	*Calliostoma ligatum*
	Starfish	*Leptasterias hexactis*	Snail	*Bittium eschrichtii*
	Barnacle	*Balanus cariosus*	Snail	*Lirularia lirulata*
	Rock snail	*Thais* sp.	Polychaetes	various spp.
	Native oyster	*Ostrea lurida*	Crustaceans	various spp.
	Rock scallop	*Hinnites giganteus*		

EXPOSED SUBTIDAL ZONE

Elevation:	Species:	Scientific Name:
Shallow, Subtidal & Sublittoral	Sea urchin	*Strongylocentrotus franciscanus*
	Abalone	*Haliotis kamtschatkana*
	Crustaceans	various spp.
	Polychaetes	various spp.



Major Benthic Invertebrates of Bedrock Substrates in the Pacific Northeast
(after Anon. 1982 and Anon. 1983a)

SEMI- PROTECTED & PROTECTED SUBTIDAL ZONE

Elevation:	Species:	Scientific Name:
0-5 m	Boring clam	*Hiatella arctica*
	Giant barnacle	*Balanus cariosus*
	Giant barnacle	*Balanus nubilus*
	Chitons	various spp.
	Clam	*Lacuna* sp.
	Spider crab	*Pugettia gracilis*
5-10 m	Green sea urchin	*Strongylocentrotus droebachiensis*
	Chitons	various spp.
	Limpets	*Acmaea mitra*
	Snail	*Calliostoma* sp.
	Snail	*Lirularia* sp.
	Spider crab	*Pugettia gracilis*
> 10 m	Gastropod	*Calyptraea* sp.
	Anemone	*Metridium senile*
	Tunicates	*Halocynthia* spp.
	Tunicate	*Ascidia* sp.
	Gumboot chiton	*Cryptochiton stelleri*
	Starfish	*Pycnopodia helianthoides*
	Starfish	*Pteraster tesselatus*
	Green sea urchin	*Strongylocentrotus droebachiensis*
	Crabs	various spp.
	Octopuses	*Octopus* spp.

Major Benthic Invertebrates of Cobble-Gravel Substrates in the Pacific Northeast
(after Anon. 1982 and Anon. 1983a)

EXPOSED INTERTIDAL ZONE

Elevation:	Species:	Scientific Name:
N/A	Barnacle	*Balanus glandula*
	Barnacle	*Balanus cariosus*
	Polychaetes	various spp.
	Amphipods	various spp.
	Isopods	various spp.
	Crustaceans	various other spp.
	Limpet	*Notoacmea persona*
	Mussel	*Mytilus edulis*

SEMI-EXPOSED INTERTIDAL ZONE

Elevation:	Species:	Scientific Name:
N/A	Barnacles	various spp.
	Gastropods	various spp.
	Limpets	various spp.
	Isopods	*Idotea wosnesenskii*
Upper	Amphipod	*Hyale* sp.
Lower	Bivalve	*Macoma balthica*
	Bivalve	*Macoma nasuta*
	Butter clam	*Saxidomus giganteus*
	Steamer clam	*Protothaca staminea*
	Bivalve	*Mysella tumida*
	Bivalve	*Cryptomya californica*
	Bivalve	*Transenella tantilla*
	Crab	*Pagurus* sp.
	Crab	*Hemigrapsus* sp.
	Polychaetes	various spp.

PROTECTED INTERTIDAL ZONE

Elevation:	Species:	Scientific Name:
Upper	Barnacles	various spp.
	Snails	various spp.
	Limpets	various spp.
	Periwinkles	various spp.
Mid	Clams	various spp.
	Littleneck clam	*Protothaca staminea*
	Polychaetes	various spp.
	Oligochaetes	various spp.
Lower	Anemones	various spp.
	Barnacles	various spp.
	Snails	various spp.
	Limpets	various spp.
	Periwinkles	various spp.
	Clams	various spp.
	Polychaetes	various spp.
	Oligochaetes	various spp.

Major Benthic Invertebrates of Cobble-Gravel Substrates in the Pacific Northeast
(after Anon. 1982 and Anon. 1983a)

SEMI-PROTECTED SUBTIDAL ZONE

Elevation:	Species:	Scientific Name:
0-5 m	Gastropods	various spp.
	Limpets	various spp.
	Crabs	various spp.
	Nematodes	various spp.
	Polychaetes	various spp.
	Tanaidaceans	various spp.
	Amphipods	various spp.
5-10 m	Holothuroids	various spp.
	Polychaetes	various spp.

Elevation:	Species:	Scientific Name:
5-10 m	Snails	various spp.
	Abalone	*Haliotis kamtschatkana*
	Starfish	various spp.
	Mysids	various spp.
	Amphipods	various spp.
	Dunginess crab	*Cancer magister*
	Shrimp	various spp.
> 10 m	Scallops	various spp.

PROTECTED SUBTIDAL ZONE

Elevation:	Species:	Scientific Name:
0-5 m	Sea cucumber	*Cucumaria miniata*
	Anemone	*Pachycerianthus fimbriatus*
	Polychaetes	various spp.
	Serpulids	various spp.
	Top snails	*Astraea gibberosa*
	Giant cucumber	*Parastichopus californicus*
	Abalone	*Haliotis kamtschatkana*
	Starfish	various spp.
	Nematodes	various spp.
	Polychaete	*Abarenicola* sp.
	Polychaete	*Capitella* sp.
	Polychaete	*Cirratulus* sp.
	Polychaete	*Armandia* sp.
	Polychaete	Family Spionidae
	Tanaidacean	*Leptochelia* sp.
	Amphipod	*Gammarus* sp.
	Nereids	various spp.
	Sabellids	various spp.

Elevation:	Species:	Scientific Name:
5-10 m	Bivalve	*Macoma* sp.
	Brittle starfish	Class Ophiuroidea
	Gastropod	*Calyptraea* sp.
	Bivalve	*Mysella* sp.
	Tenaidacean	*Leptochelia* sp.
	Nematodes	various spp.
	Polychaete	*Capitella* sp
	Polychaete	*Abarenicola* sp.
	Polychaete	*Cirratulus* sp.
	Polychaete	*Armandia* sp.
	Polychaete	Family Spionidae
	Grammarids	various spp.
	Mussel	*Modiolus rectus*
	Scallops	various spp.

Major Benthic Invertebrates of Sand Substrates in the Pacific Northeast
(after Anon. 1982 and Anon. 1983a)

EXPOSED INTERTIDAL ZONE

Elevation:	Species:	Scientific Name:
N/A	Blood worms	various spp.
	Isopods	various spp.
	Nemerteans	various spp.
	Razor clam	*Siliqua patula*
	Purple olive snail	*Olivella biplicata*
	Amphipods	various spp.
	Crabs	various spp.
	Polychaetes	various spp.

SEMI-EXPOSED INTERTIDAL ZONE

Elevation:	Species:	Scientific Name:
Upper	Beach hopper	*Orchestia traskiana*
	Isopods	various spp.
Mid	Polychaete	*Nephtys caeca*
	Polychaete	*Nephtys caecoides*
	Polychaete	*Nephtys longosetosa*
	Oligochaete	*Olivenia justiformis*
	Dunginess crab	*Cancer magister*
	Hairy hermit crab	*Pagurus* sp.
	Bivalve	*Macoma* sp.
	Bivalve	*Mya* sp.
	Bivalve	*Tellina* sp.
Lower	Polychaetes	various spp.
	Nemerteans	various spp.

PROTECTED INTERTIDAL ZONE

Elevation:	Species:	Scientific Name:
N/A	Amphipod	*Ansiogammarus confervicolus*
	Amphipod	*Pontogeneia* sp.
	Amphipod	*Ischyrocerus anguipes*
	Amphipod	*Paraphoxus* sp.
	Hermit crab	*Pagurus* sp.
	Isopods	various spp.
	Ghost shrimp	*Callianassa californiensis*
	Mud shrimp	*Upogebia pugettensis*
	Lugworms	*Abarenicola* spp.
	Bamboo worm	*Axiothella rubrocincta*
	Clam	*Tresus capax*
	Clam	*Macoma secta*
	Dunginess crab	*Cancer magister*

EXPOSED SUBTIDAL ZONE

Elevation:	Species:	Scientific Name:
5-10 m	Polychaetes	various spp.
	Mysids	various spp.
	Amphipods	various spp.
	Crustaceans	various small spp.
	Copepods	harpaticoid spp.

Major Benthic Invertebrates of Sand Substrates in the Pacific Northeast
(after Anon. 1982 and Anon. 1983a)

PROTECTED SUBTIDAL ZONE

Elevation:	Species:	Scientific Name:
0-10 m	Polychaete	*Nephtys* sp.
	Mysid	*Archaomysis grebnitskii*
	Amphipods	various spp.
	Bivalve	*Tellina* sp.
	Bivalve	*Mysella* sp.
	Polychaete	*Scoloplos* sp.
	Polychaete	*Polydora* sp.
	Cumacean	*Diastylis* sp.
	Isopod	*Idotea* sp.
	Amphipods	*Gammarid* spp.
	Bivalve	*Clinocardium* sp.
	Bivalve	*Protothaca* sp.

Elevation:	Species:	Scientific Name:
0-10 m	Nemerteans	various spp.
	Echinoderms	various spp.
	Polychaete	*Hemipodus* sp.
	Polychaete	*Glycinde* sp.
	Crab	*Cancer* sp.
	Gastropod	*Nassarius* sp.
	Gastropod	*Polinices* sp.
	Sea Cucumber	*Leptosynapta* sp.
	Crab	*Pugettia gracilis*
	Crab	*Cancer productus*
	Crab	*Telmessus cheiragonus*
	Geoduck	*Panope generosa*

Major Benthic Invertebrates of Mud-Ooze Substrates in the Pacific Northeast
(after Anon. 1983a)

PROTECTED INTERTIDAL ZONE

Elevation:	Species:	Scientific Name:
N/A	Clam	*Tresus nuttalli*
	Clam	*Saxidomas giganteus*
	Clam	*Protothaca staminea*
	Clam	*Macoma* spp.
	Polychaete	*Abarenicola* sp.
	Polychaete	*Capitella capitata*
	Polychaete	*Hemipodus* sp.
	Dunginess crab	*Cancer magister*

PROTECTED SUBTIDAL ZONE

Elevation:	Species:	Scientific Name:
Shallow	Nemertean	*Paranemertes* sp.
	Polychaete	*Chelionereis cyclurus*
	Polychaete	*Nepthys caeca*
	Bivalve	*Psephidia lordi*
	Shrimp	*Pandalus jordani*
	Shrimp	*Pandalus borealis*
	Shrimp	*Pandalus hypsinotus*
	Dunginess crab	*Cancer magister*

Certain benthic invertebrates deserve special consideration because of their susceptibility to impact by the sport and / or commercial fishery. Those include echinoderms, oysters, mussels, clams, scallops, abalone, cephalopods, crabs, and shrimp. The euphasiids have been mentioned as part of the zooplankton.

Two echinoderms are fished widely in British Columbian waters: Sea urchin and sea cucumber. Of the many species of sea urchin present in British Columbia, only three are considered edible: red sea urchin, *Strongylocentrotus franciscanus* ; green sea urchin, *S. droebachiensis* ; and purple sea urchin, *S. purpuratus* ; of which only the red sea urchin is taken commercially (Bernard 1982). Green sea urchin is found on rocky shores and in kelp beds from the low tide line to 1157 metres depth (McConnaughey & McConnaughey 1985). The purple sea urchin is found on rocky shores with moderately strong surf, from low tide line to 160 metres depth, where it is often able to gain security by wearing away a depression in relatively soft rock (Kozloff 1973, McConnaughey & McConnaughey 1985). The red sea urchin, which occupies both quiet and open, rocky shores from low tide line to 91 metres depth, is a favourite part of the diet of the California sea otter, and may be absent from the sea otter's range (Kozloff 1973, McConnaughey & McConnaughey 1985). There are known concentrations of red sea urchin on the east coast of Moresby Island as well as along the mainland shores of Hecate Strait and Queen Charlotte Sound (Anon. 1980b).

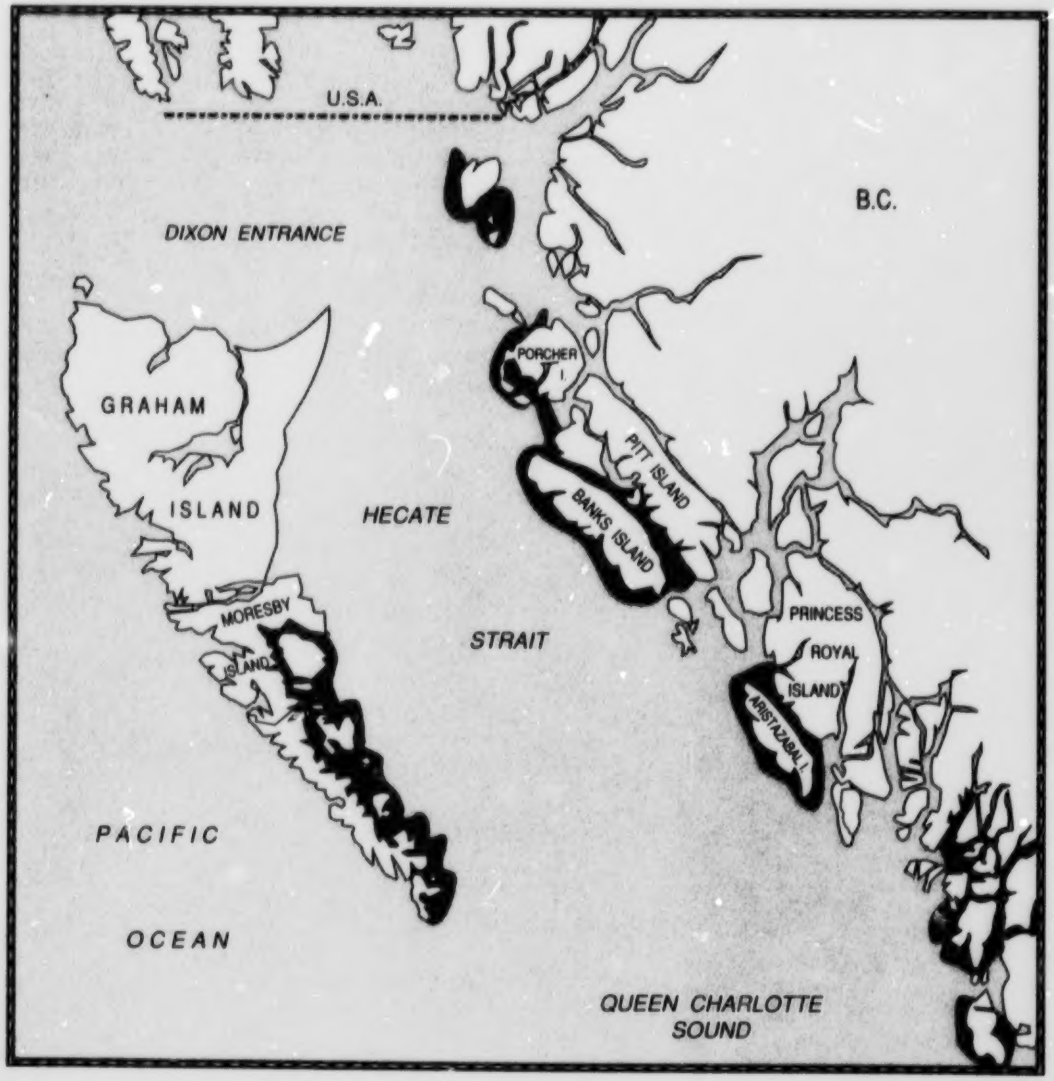
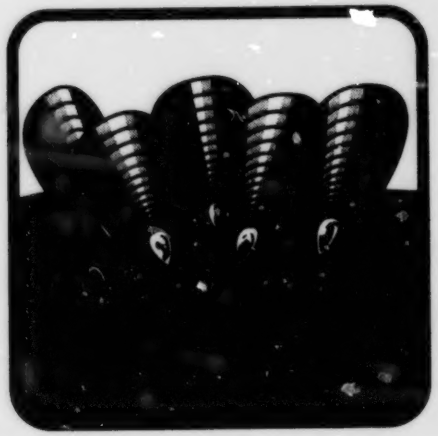


Figure 142. Major concentrations of sea urchins (dark shading) in the Queen Charlotte Islands area. Boundaries are approximate. (after Anon. 1980b)

A variety of sea cucumber genera occupy a range of marine habitats in British Columbia from the shallow intertidal to the deep ocean (Jamieson & Francis 1986). Among the more common examples are: California sea cucumber, *Parastichopus californicus*; red sea cucumber, *Cucumaria miniata*; *Cucumaria lubrica*; *Cucumaria pseudocurata*; stiff-footed sea cucumber,*Eupentacta quinquesemita*; slipper sea cucumber, *Psolus chitonoides*; and *Psolidium bullatum* (Kozloff 1973). The limited commercial fishery for sea cucumber in British Columbia takes place in Georgia Strait, and is restriced to our largest species, red sea cucumber (Jamieson & Francis 1986).

The one species of oyster, the native or Olympia oyster, *Ostrea lurida*, which inhabits northern British Columbian waters is of little commercial value in the area of the Queen Charlotte Islands (Anon. 1983a). It occurs on rocky shores near the low tide line and on the mud or gravel bottoms of estuaries and embayments (McConnaughey & McConnaughey 1985) and is very sensitive to temperature changes (Quayle 1960). The only other two species of oyster found in British Columbia, the Japanese oyster, *Crassostrea gigas* (the primary commercial species in the province), and the Atlantic oyster, *Crassostrea virginica* (the introduction of which has not been commercially successful) are found only in more southerly waters (Jamieson & Francis 1986).

There are four varieties of mussels found in the Queen Charlottte Islands area: the blue mussel, *Mytilus edulus*; the Californian mussel, *Mytilus californianus*; and the horse mussels, *Modiolus capax* and *M. rectus*, of which the horse mussels are far less abundant (Anon. 1983a). The blue mussel and California mussel, the only two species harvested commercially, are found in shallow intertidal areas, restricted to that range by starfish predation at depth and dessication above. The mussels occur throughout the Queen Charlotte Islands on rocky shores. While the California mussel is restricted to exposed coasts, the blue mussel occurs on protected coasts as well as exposed ones. It was suggested as recently as 1982 (Bernard) that it was unnecessary to establish a data base for the management of mussels in British Columbia inasmuch as the dollar values of landings were small and increased use would occur through mariculture rather than wild harvest. However, it has been the experience in the past three years in the vicinity of Pacific Rim National Park that the harvest of wild mussels has increased at a dramatic rate. The situation is all the more alarming to resource managers in that the mussel is one of the filter feeding bivalves which is capable of causing paralyic shellfish poisoning in humans as well as in animal life.



Numerous species of clams, as described by D.B. Quayle (1960) inhabit the area of the Queen Charlotte Islands. Of those, only four are susceptible to sport and commercial fishing pressure: the butter clam, *Saxidomus giganteus;* the native littleneck clam, *Protothaca staminea;* the razor clam, *Siliqua patula;* and the geoduck clam, *Panope abrupta.* The exotic manila clam, *Tapes philipinarum,* is restricted to southern British Columbian waters. The butter clam is found in the lower intertidal zone to about 15 metres depth, typically in a sand-shell-mud-gravel substrate, where it burrows to 25 centimetres (Jamieson & Francis 1986). The native littleneck clam inhabits a range from just above the mid intertidal zone to 10 metres depth, burrowing in a gravel substrate to 15 centimeters (Anon. 1983a, Jamieson & Francis 1986). The razor clam occupies a range from the mid intertidal zone to a depth of 20 metres, preferring the upper 25 centimetres of sand on exposed beaches (Anon. 1983a). The geoduck is the only subtidal clam to be exploited commercially. While they can occupy a range from the lower intertidal to 120 metres depth, most venture no higher than 8 metres deep while burrowing up to 1 metre in a sand or sandy gravel substrate (Anon. 1983a, Jamieson & Francis 1986). Clam populations are more concentrated on the eastern and northern shores of the Queen Charlotte Islands. As is the case with all filter-feeding bivalves, they are capable of concentrating paralytic shellfish poisoning.

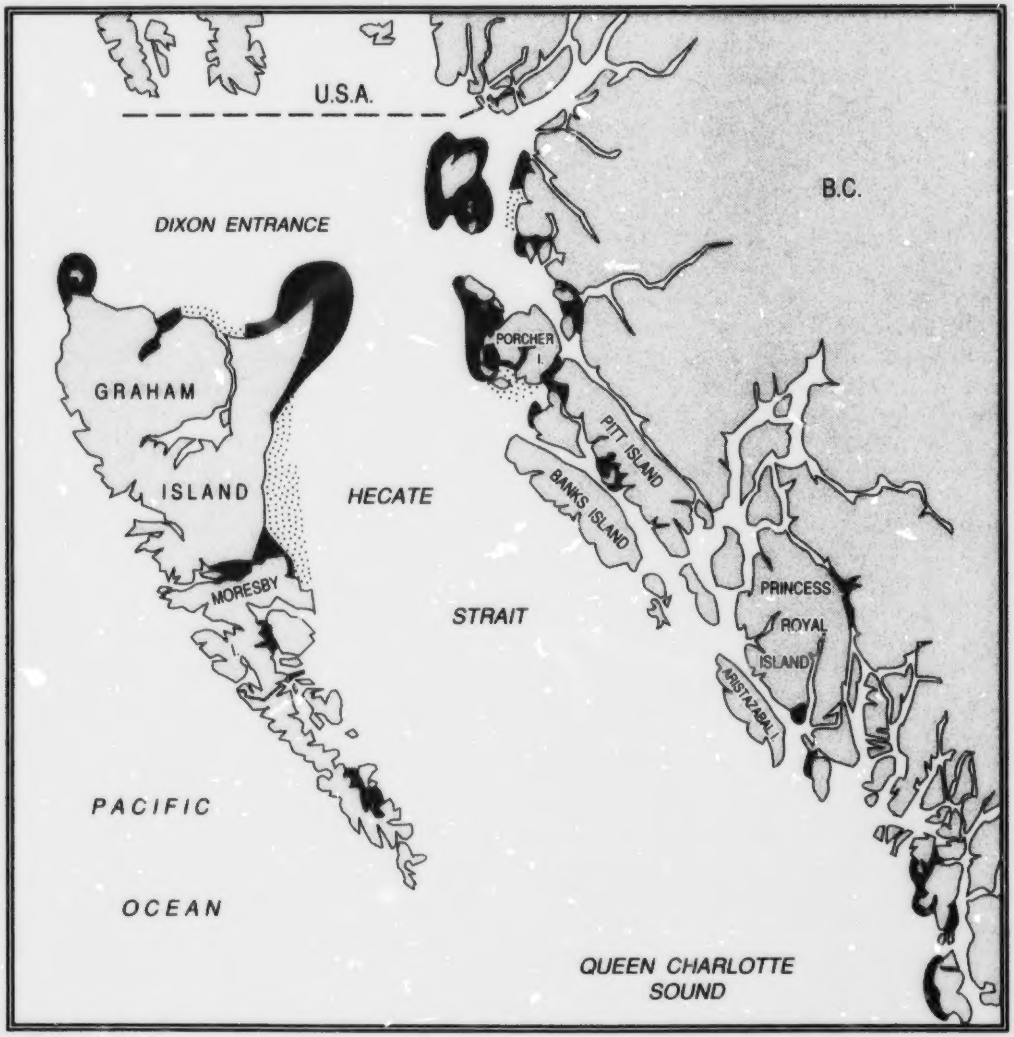


Figure 143. Major concentrations of geoducks (dark shade) and other clams (dots) in the Queen Charlotte Islands area. Boundaries are approximate (after Anon. 1975a, 1976b, 1978g, 1980b; Bourne 1969a)

British Columbian coastal waters are home to some 13 species of scallops, though 9 are rare or deep-water species. The 4 species which are large or plentiful to attract sport and commercial interest are: the weathervane scallop, *Patinopecten caurinus* ; the rock scallop, *Crassadoma gigantea* ; the pink scallop, *Chlamys rubida*; and the spiney scallop, *Chlamys hastata* (Jamieson & Francis 1986). The weathervane scallop prefers a sand or mud substrate at 20 to 200 metres depth. The rock scallop occurs mostly on rocky shores over a range from the lowest intertidal to 80 metres depth. The pink scallop and the spiny scallop are most often found in a strong current, on a firm gravel or rock bottom, but whereas the pink scallop occurs at 5-200 metres depth, the spiny scallop occurs at 5-150 metres depth. In common with other filtre-feeding bivalves, the scallop can carry paralytic shellfish poisoning. Unlike other bivalves, it is mobile, propelling itself by expelling water. Large concentrations of scallops occur on the northeast corner of Graham Island (Anon. 1983a).

The only abalone found in British Columbia is the northern abalone, *Haliotis kamtschatkana*. While most are found between the lower intertidal zone and 10 metres depth, there is a record of an individual at 100 metres. As an herbivore, they are often associated with kelp beds, and usually occupy a rocky substrate in the area of a moderate to strong current flow of 2.0 to 2.5 knots. Their distribution tends to be clumped, and often takes place on the barren substrate cleared by sea urchins

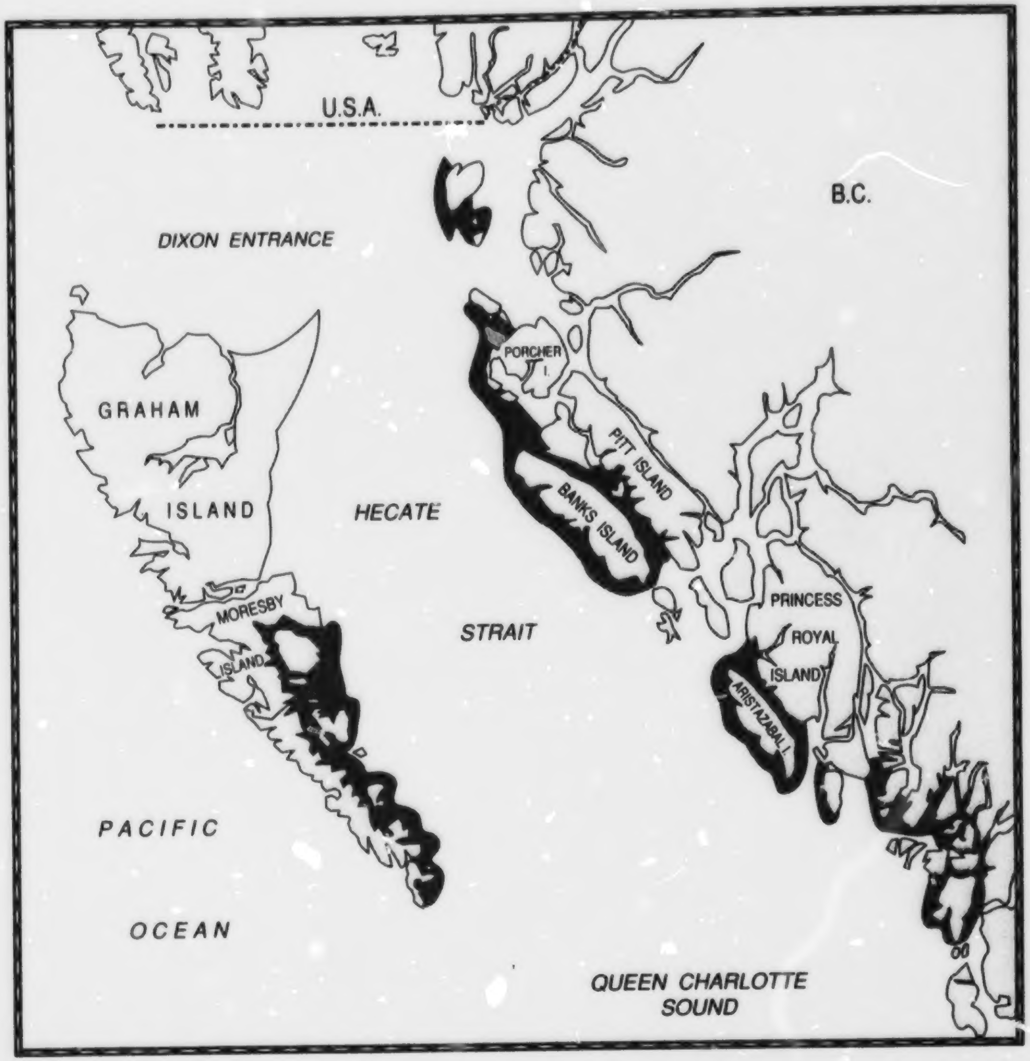


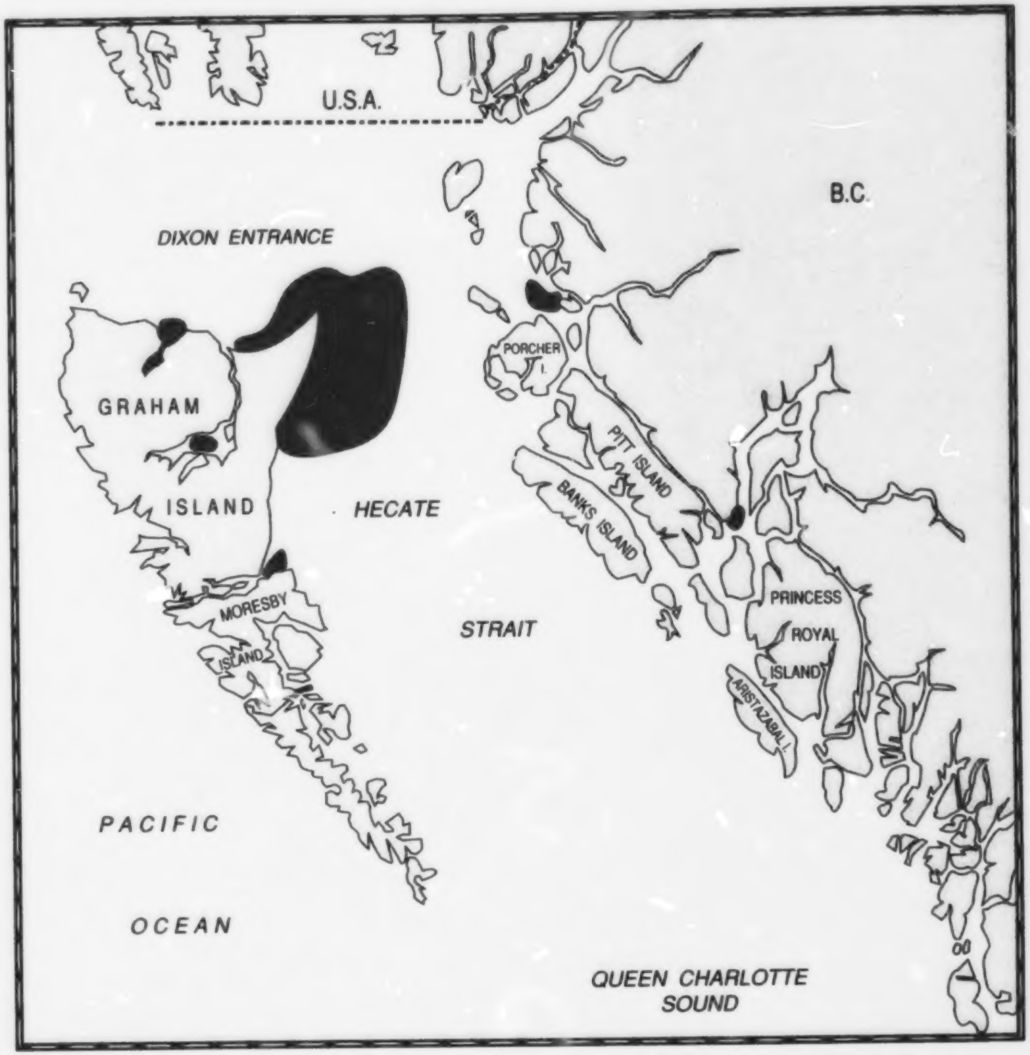
Figure 144. Major concentrations of abalone (dark shade) in the Queen Charlotte area. Boundaries are approximate. (after Anon. 1980b)

(Jamieson & Francis 1986, Anon. 1983a). A sharp increase in abalone landings in the early to mid 1970's , following years of no regulation of the fishery, left stocks throughout British Columbia in decline (Sloan & Breen 1988). A 1976 study (Adkens & Stefanson 1977) of harvested and unharvested abalone populations on the east coast of Moresby Island revealed a reduction in abalone densities due to fishing from original levels of 5-10 per square metre to about one per square metre. As well, abalone were found to be of a larger size in semi-protected kelp beds where potentially competitive sea urchin were scarce.

Cephalopods are represented in British Columbian waters by the octopods and the squid. Three species of octopus have been recorded: *Octopus dofleini, O. rubescens and O. leiodema.* Of these only *O. dofleini*, the giant pacific octopus, is large enough to be exploited commercially. The giant Pacific octopus is common in depths of up to 90 metres, on sandy bottoms, between rocky shores and areas abundant in crab, the favourite food of the octopus (Anon 1983a). The commercial octopus fishery is relatively small, and most of what there is exists as a by-catch in the shrimp and groundfish trawling (Jamieson & Francis 1986).

Four of the 17 species of squid found in British Columbia waters are of potential commercial value: the opal squid, *Loligo opalscens*; the red squid, *Berryteuthis magister*; the nail squid, *Onychoteuthis borealijaponie*; and the flying squid, *Ommastrephes bartrami* (Jamieson & Francis 1986). Of those, the red squid (which spends most of its time near the ocean floor at depths as great as 4,600 metres), and the nail squid (which spends the day at depths of approximately 400 metres along the Continental shelf, rising towards the surface at night) are not currently exploited in the eastern Pacific. The flying squid only comes within 50 kilometres of the British Columbia coast during the summer months. The opal squid is common from the intertidal zone to depths of 250 metres. Important spawning sites for the opal squid include Virago Sound and Naden Sound and their reaches on Graham Island (Anon 1980b).

While the species of crab found in British Columbian waters number 35, only five of those are large enough to attract the attention of commercial and sport fishermen: the Dunginess crab, *Cancer magister*; the red rock crab, C. productus; the deep-water, golden king crab, *Lithodes aequispina*; and the shallow-water, red king crab, *Paralithodes cantschatica* (Jamieson and Francis 1986). While the tanner crab, *Chionoecetes tanneri*, is theoretically prone to exploitation, its distribution is restricted by low salinities and high temperatures (Anon 1983a, Jamieson & Francis 1986). Commercial landings of the two species of king crab are relatively few (even the more shallow-dwelling red king crab is found as deep as 400 metres), and the red rock crab is subject primarily to a recreational fishery. The Dunginess crab is of high value to both the sport and commercial fishery. Preferring a sand-mud substrate, it inhabits shallow waters in bays and estuaries for most of the year, though its range extends from the intertidal to 100 metres depth in the offshore (Anon. 1983a). The majority of the British Columbia commercial crab catch of Dunginess crabs has been taken in the Queen Charlotte Islands area in the parts of McIntyre Bay and Hecate Strait which overlay the Argonaut Plain (Jamieson and Francis 1986).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B.C.
DIXON ENTRANCE
GRAHAM
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HECATE
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PORCHER
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PITT ISLAND
BANKS ISLAND
PRINCESS
ROYAL
ISLAND
ARISTAZABAL I.
PACIFIC
OCEAN
QUEEN CHARLOTTE
SOUND

Figure 145. Major concentrations of Dunginess crabs (dark shade) in the Queen Charlotte Islands area. (after Jamieson & Francis 1986, Anon. 1980b and Anon. 1978g)

Some 85 species of shrimp have been noted in British Columbia, but the sport and commercial fisheries impact on only six of those: the sidestripe shrimp, *Pandalopis dispar*; the pink shrimp, *Pandalus borealis*; the smooth pink shrimp, *Pandalus jordani*; the coonstripe shrimp, *Pandalus danae*; the humpback shrimp, *Pandalus hypsinotu* ; and the prawn, *Pandalus platyceros* (Jamieson and Francis 1986). The flexed pandalid shrimp, *Pandalus goniurus*, while of no commercial significance in British Columbia, has limited commercial importance in Alaska (Anon. 1983a). The six commercial species are partitioned by a combination of substrate preference and depth preference. A prawn trap exploration of the Queen Charlotte Islands in 1980 (Boutillier *et al.*) Tasu Sound, Juan Perez Sound and Darwin Sound as the best areas for prawn production.

Habitat Preferences of Commercially Important Shrimp Species of British Columbia (Jamieson and Francis 1986, Anon. 1983a, McConnaughey & McConnaughey 1985)

Species:	Bottom Type:	Preferred Depth (m):	Range of Depth (m):
Sidestripe shrimp *Pandalopsis dispar*	mud	120-140	40-700
Pink shrimp *Pandalus borealis*	mud	54-90	to 700
Smooth pink shrimp *Pandalus jordani*	mud &/or sand/mud	90-180	35-450
Coonstripe shrimp *Pandalus danae*	gravel or sand	20-65	to 182
Humpback shrimp *Pandalus hypsinotus*	coarse or rocky	60-80	5-200
Prawn *Pandalus platyceros*	rocky	70-90	5-200

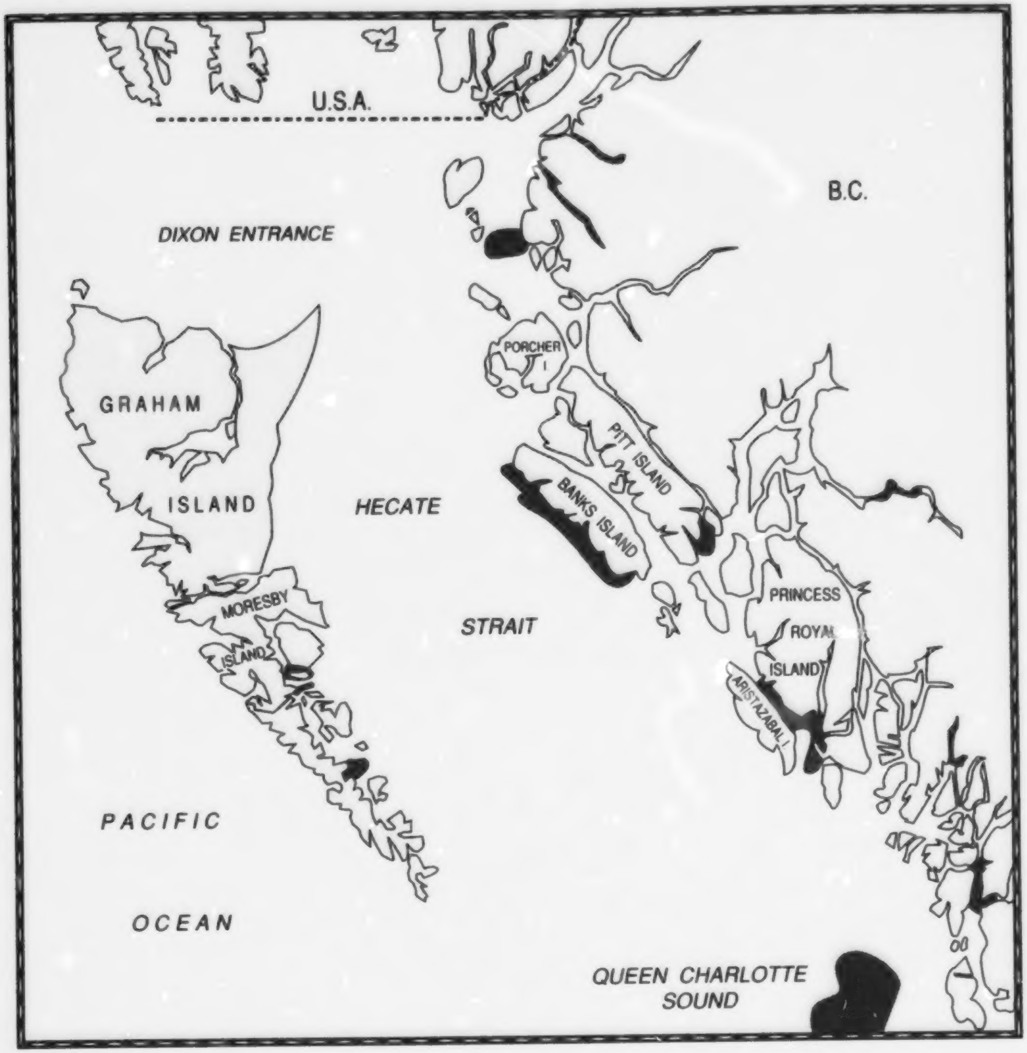


Figure 146. Major concentrations of shrimps and prawns in the Queen Charlotte area. Boundaries are approximate (after Anon. 1978g)

-Fish

The coastal waters of the Queen Charlotte Islands are likely home to some 315 species of fish occupying a wide variety of marine habitats (Northcote *et al.* 1989). For the purposes of this document, the marine fish species of the Queen Charlotte Islands will be discussed by the following categories: ichthyoplankton, groundfish, anadromous species, pelagic species, inshore species, and endemic, rare or endangered species.

The only sources of information on ichthyoplankton numbers and distribution in the Queen Charlotte Islands to date are the 1980 cruises by the Pacific Marine Biological Station (Mason *et al.* 1981a,b,c,d). The study period covered January to April only. During that time, the abundance was observed to begin increasing generally in March and April, which suggests that the planktonic bloom continued beyond the observation period (Anon. 1982). Some of the samples were quite small; therefore, the standard error of the population estimate is large. Among the ichthyoplankton recorded were: Pacific tomcod, *Microgadus proximus*; Pacific sand lance, *Ammodytes hexapterus* ; flatfish species, *Pleuronectidae*; walleye poollock, *Theragra challcogramma*; Pacific hake, *Merluccius productus*; Pacific halibut, *Hippoglossus stenolepsis*; rockfish species, *Scorpionidae*; herring, *Clupea harengus pallasi*; and greenlings, *Hexigrammidae* family (Anon. 1982, Anon. 1983a). The Hecate Strait shoals and the Cook and Goose Island banks in the southeast corner of Queen Charlotte Sound showed the greatest abundance of larvae for most species, though rockfish and sandlance larvae were distributed over the whole of the northern shelf by April (though sandlance larvae showed greater concentrations over the shoals), and walleye pollock eggs and larvae were abundant in Dixon Entrance in April. While central Queen Charlotte Sound and western Dixon Entrance were thinly populated by ichthyoplankton until April, eastern Dixon Entrance showed an abundance of ichthyoplankton. Among the populations of ichthyoplankton in the northern shelf area, sandlance larvae make up a consistant and in some instances a major part of the diet of commercial fish species (Anon. 1982).

The groundfish of the northern shelf area, those species which live at or near the sea floor, include the roundfish, rockfish and flatfish. More than 90 species are known or expected to occur in the northern shelf area of British Columbia.

Groundfish of Queen Charlotte Islands Offshore Waters (from Anon. 1983a after Hart 1973).

Family:	Species Name:	Scientific Name:
Dogsfish sharks (*Squalidae*)	Pacific sleeper shark	*Somniosus pacificus*
	Spiny dogfish	*Squalus acanthias*
Electric rays (*Torrpedinidae*)	Pacific electric ray	*Torpedo californica*
Skates (*Rajidae*)	Deepsea skate	*Raja abyssicola*
	Big Skate	*R. binoculata*
	Black skate	*R. kincaidi*
	Longnose skate	*R. rhina*
	Starry skate	*R. stellulata*
Chimeras (*Chimaeridae*)	Ratfish	*Hydrolagus colliei*
Codfishes (*Gadidae*)	Pacific cod	*Gadus macrocephalus*
	Pacific hake	*Merluccius productus*
	Pacific tomcod	*Microgadus proximus*
	Walleye pollock	*Theragra chalco gramma*
Wolffishes (*Anarhichadidae*)	Wolf-eel	*Anarrhichthys ocellatus*
Prowfishes (*Zaproridae*)	Prowfish	*Zaprora silenus*

Groundfish of Queen Charlotte Islands Offshore Waters (continued)
(from Anon. 1983a after Hart 1973)

Family:	Species Name:	Scientific Name:
Sablefishes *(Anoplopomatidae)*	Sablefish	*Anoplopoma fimbria*
	Skilfish	*Erilepis zonifer*
Greenlings *(Hexagrammidae)*	Lingcod	*Ophiodon elongatus*
Sculpins *(Cottidae)*	Padded sculpin	*Artedius fenestralis*
	Soft sculpin	*Gilbertidia sigalutes*
	Bigmouth sculpin	*Hemitripterus bolini*
	Northern sculpin	*Icelinus borealis*
	Dusky sculpin	*I. burchami*
	Threadfin sculpin	*I. filamentosus*
	Spotfin sculpin	*I. tenuis*
	Thorny sculpin*	*Icelus spiniger*
	Blackfin sculpin	*Malacocottus kincaidi*
	Smallsail sculpin	*Nautichthys robustus*
	Thornback sculpin*	*Paricelinus hopliticus*
	Tadpole sculpin	*Psychrolutes paradoxus*
	Slim sculpin	*Radulinus asprellus*
	Darter sculpin**	*R. boleoides*

*single record only, **two records only

Groundfish of Queen Charlotte Islands Offshore Waters (continued)
(from Anon. 1983a after Hart 1973)

Family:	Species Name:	Scientific Name:
Rockfish	Rougheye rockfish	*Sebastes aleutianus*
	Pacific ocean perch	*S. alutus*
	Brown rockfish	*S. auriculatus*
	Redbanded rockfish	*S. babcocki*
	Shortraker rockfish	*S. borealis*
	Silvergray rockfish	*S. brevispinis*
	Copper rockfsih	*S. caurinus*
	Dusky rockfish	*S. ciliatus*
	Darkblotched rockfish	*S. crameri*
	Splitnose rockfish	*S. diploproa*
	Greenstriped rockfish	*S. elongatus*
	Puget Sound rockfish	*S. emphaeus*
	Widow rockfish	*S. entomelas*
	Yellowtail rockfish	*S. flavidus*
	Rosethorn rockfish	*S. helvomaculatus*
	Quillback rockfish	*S. maliger*
	Black rockfish	*S. melanops*
	Vermillion rockfish	*S. miniatus*
	Blue rockfish	*S. mystinus*
	China rockfish	*S. nebulosus*
	Tiger rockfish	*S. nigrocinctus*
	Bocaccio	*S. paucispinis*
	Canary rockfish	*S. pinniger*
	Redstripe rockfish	*S. proriger*
	Yellowmouth rockfish	*S. reedi*
	Yelloweye rockfish	*S. ruberrimus*
	Harlequin rockfish	*S. variegatus*
	Pygmy rockfish	*S. wilsoni*
	Sharpchin rockfish	*S. zacentrus*
	Shortspine thornyhead	*Sebastolobus alascanus*
	Longspine thornyhead	*S. altivelis*

Groundfish of Queen Charlotte Islands Offshore Waters (from Anon. 1983a after Hart 1973).continued

Family:	Species Name:	Scientific Name:
Poachers *(Agonidae)*	Gray starsnout	*Asterotheca alascana*
	Spinycheek starsnout	*A. infraspinata*
	Bigeye poacher	*A. pentacanthus*
	Blackfin poacher	*Bathyagonus nigripinnis*
Lumpfishes & snailfishes *(Cyclopteridae)*	Smalldisc snailfish	*Careproctus gilberti*
	Blacktail snailfish	*C. melanurus*
	Abyssal snailfish	*C. ovigerum*
	Tadpole snailfish	*Nectoliparis pelagicus*
	Prickly snailfish	*Paraliparis deani*
Righteye flounders (Pleuronectidae)	Arrowtooth flounder	*Atheresthes stomias*
	Roughscale sole	*Clidoderma asperrimum*
	Deepsea sole	*Embassichthys bathybius*
	Petrale sole	*Eopsetta jordani*
	Rex sole	*Glyptocephalus zachirus*
	Flathead sole	*Hippoglossoides elassodon*
	Pacific halibut	*Hippoglossus stenolepis*
	Sole (hybrid)	*Inopsetta ischyra*
	Butter sole	*Isopsetta isolepis*
	Rock sole	*Lepidopsetta bilineata*
	Yellowfin sole	*Limanda aspera*
	Slender sole	*Lyopsetta exilis*
	Dover sole	*Microstomus pacificus*
	English sole	*Parophrys vetulus*
	Starry flounder	*Platichthys stellatus*
	C-O sole	*Pleuronichthys coenosus*
	Curlfin sole	*P. decurrens*
	Greenland turbot	*Reinhardtius hippoglossoides*

From the limited information available, Hecate Strait and Queen Charlotte Sound are recognized as important spawning and rearing areas for groundfish. High concentrations are found on Cook Bank (Cape Scott Ground) and Goose Island Bank as well as in western Hecate Strait and southern Dixon Entrance. Adults are found as a rule in deeper waters, while the young stay closer to shore. The commercial fishery is the source for much of the existing knowledge regarding groundfish populations (Anon. 1983a).

Roundfish (which include cod, pollock, lingcod and the like) spawn in winter, and their eggs are pelagic, with the exception of the Pacific cod and lingcod, the eggs of which are found on or near the bottom. The pelagic, larval stages move from inshore waters in their early stages to the deeper offshore as they develop (Anon. 1983a).

Rockfish breed in late winter and spring, commonly in deeper waters, and they are oviviparous. Wile the young are initially pelagic, they become demersal as early as one year of age (Anon. 1983a).

Primarily bottom dwellers, the flatfish may move to the surface to feed and to shallower waters to spawn. The eggs of most species are pelagic, though some may be demersal. New larvae settle to the bottom. Juveniles occupy shallower waters, moving into the deeper waters only as they mature (Anon. 1983a). An exception to the demersal rule for flatfish is the starry flounder which can spend its whole life in shallow water, commonly near a river mouth (Hart 1973).

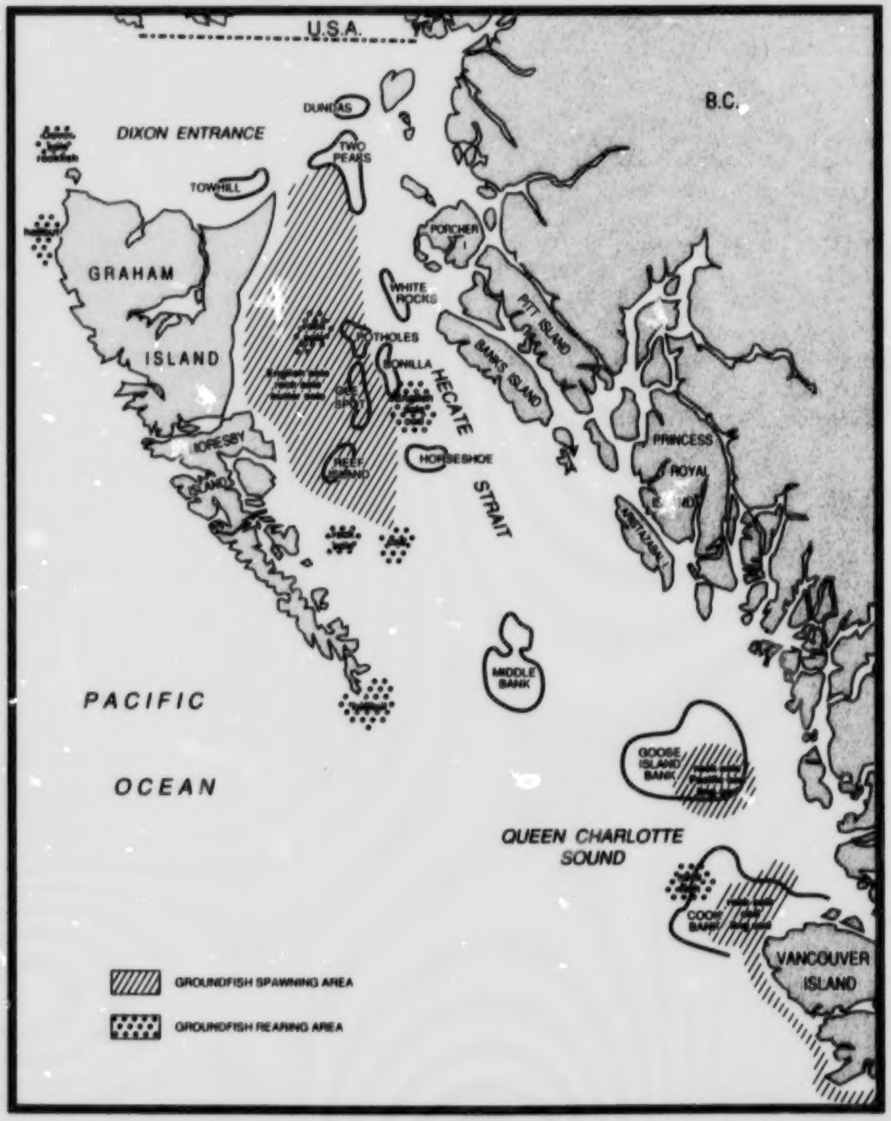

U.S.A.
B.C.
DIXON ENTRANCE
DUNDAS
TWO PEAKS
TOWHILL
PORCHER
GRAHAM
ISLAND
WHITE ROCKS
PITT ISLAND
BANKS ISLAND
POTHOLES
BONILLA
ONE SPOT
HECATE
STRAIT
REEF ISLAND
HORSESHOE
MORESBY
PRINCESS
ROYAL
ISLAND
MIDDLE BANK
PACIFIC
OCEAN
GOOSE ISLAND BANK
QUEEN CHARLOTTE
SOUND
COOK BANK
VANCOUVER ISLAND
GROUNDFISH SPAWNING AREA
GROUNDFISH REARING AREA

Figure 147. Groundfish resources in the west coast area (after Anon. 1978d)

While the anadromous species of the northern shelf area of British Columbia number far fewer than those of groundfish, the fewer number of species belies their great importance to both the sport and commercial fishery. The salmonids are of particular significance.

There are five species of salmon in British Columbian waters, all of which have importance to the commercial and sport fisheries and all of which share similar life histories: Pink salmon *(Oncorhynchus gorbuscha)*, Chum salmon *(O. keta)*, Coho salmon *(O. kisutch)*, Sockeye salmon *(O. nerka)*, and Chinook salmon *(O. tshawytsch)*. Steelhead, the anadromous form of the rainbow trout *(O. mykiss)* is a sixth salmonid which represents an important anadromous species in British Columbia. Recent taxonomic changes (Kendall 1988) ally it more closely with pacific Salmon (*Oncorhynchus* spp.) than had heretofore been believed (its former name was *Salmo gairdneri*). Spawning in a variety of fresh water habitats occurs for the Pacific salmon commonly in late summer or fall, with the eggs hatching the following spring. The length of time for the seaward migration varies from species to species, though full maturity is attained in salt water, whether inshore or offshore. The life cycle ranges from two to eight years. Dixon Entrance, Hecate Strait, and Queen Charlotte sound are migratory corridors for stocks of all five species of Pacific salmon. Coastal waters off the west coast of the Queen Charlotte Islands are migratory corridors for all but the chinook salmon (Anon. 1982).

Anadromous fish of Queen Charlotte Islands Offshore Waters (from Anon. 1983a after Hart 1973 and Hoos 1975; Kendall 1988).

Family:	Species Name:	Scientific Name:
Lamprey *(Petromyzontidae)*	Pacific lamprey River lamprey	*Lampetra tridentatus* *L. ayresi*
Sturgeon *(Acipenseridae)*	Green sturgeon White sturgeon	*Acipenser medirostris* *A. transmontanus*
Herring *(Clupeidae)*	American shad	*Alosa sapidissima*
Salmon, trout, char *(Salmonidae)*	Pink salmon Chum salmon Coho salmon Sockeye salmon Chinook salmon Cutthroat trout Steelhead trout Dolly Varden	*Oncorhynchus gorbuscha* *O. keta* *O. kisutch* *O. nerka* *O. tshawytscha* *O. clarki* *O. mykiss* *Salvelinus malma*
Smelts *(Osmeridae)*	Longfin smelt Eulachon	*Spirinchus thaleichthys* *Thaleichthys pacificus*

To get an idea of the relative importance of the salmonid stocks with respect to the population in British Columbian ocean waters, it is possible to compare ten-year average commercial catch figures for the Northern Coastal Zone (which includes Department of Fisheries and Oceans Statistical Areas 1-5, covering Dixon Entrance, most of Hecate Strait and waters off the west coast of the Queen Charlotte Islands) and the Central Coastal Zone (which includes Department of Fisheries and Oceans Statistical Areas 6-11 and 30, covering southeastern Hecate Strait, Queen Charlotte Sound and the open waters west of Queen Charlotte Sound with figures for the whole tidal water salmon fishery.

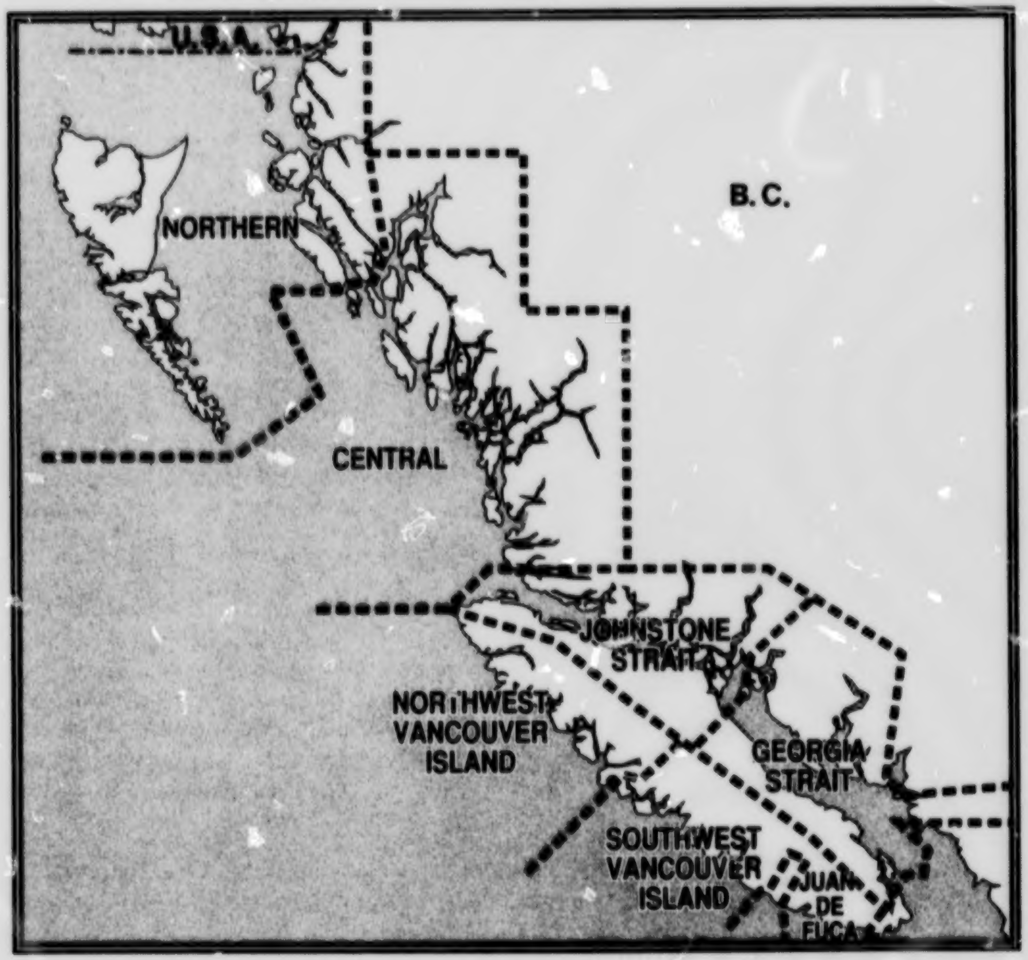

U.S.A.
B.C.
NORTHERN
CENTRAL
JOHNSTONE STRAIT
NORTHWEST VANCOUVER ISLAND
GEORGIA STRAIT
SOUTHWEST VANCOUVER ISLAND
JUAN DE FUCA

Figure 148. Department of Fisheries and Oceans coastal zones for British Columbia (after Archibald & Gaham 1981)

Average Commercial Catch of Pacific Salmon: 1970-1979 (percentages)
(after Archibald & Graham 1981)

Zone:	Sockeye	Coho	Pink*	Pink**	Chum	Chinook	Steelhead	All Salmon
Northern	24	17	29	22	19	17	53	24
Central	16	16	52	14	32	12	17	29
Other Zones	60	67	19	64	49	71	30	47
All Zones	100	100	100	100	100	100	100	100

* even years, ** odd years

The pelagic fish species of British Columbia (exclusive of the salmon, but inclusive of the bathypelagic species) are numerous. Yet because they are largely without import to the commercial or sport fishery, many remain poorly known. That is particularly true for the bathypelagic species, living at 1000 to 3000 metre depths (Anon. 1983a). Both the mesopelagic and bathypelagic species may become food for salmonids as they make their diel migration to epepelagic waters (Northcote *et al.* 1989). The 0-200 metre deep epipelagic zone corresponds to the inshore depth for the continental shelf (Marshall 1979). Beneath that, the 200-1000 metre deep mesopelagic zone harbours fishes which migrate upwards to feed upon epipelagic plankton at night.

Pelagic Fish of Queen Charlotte Islands Offshore Waters (from Anon 1983a after Hart 1973).

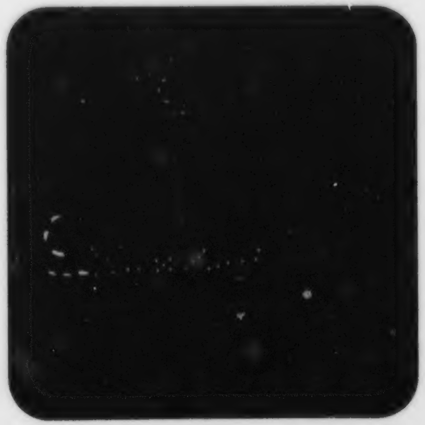
Family:	Species Name:	Scientific Name:
Hagfish (Order *Myxiniformes*)	Black hagfish	*Eptatretus deani*
	Pacific hagfish	*E. stouti*
Mackerel sharks (*Lamnidae*)	White shark	*Carcharodon carcharias*
	Basking shark	*Cetorhinus maximus*
	Salmon shark	*Lamna ditropis*
Requiem sharks (*Charcharhinidae*)	Soupfin shark	*Galeorhinus zyopterus*
	Blue shark	*Prionace glauca*
Sawpalates (*Serrivomeridae*)	Crossthroat sawpalate	*Serrivomer jesperseni*
Snipe eels (*Nemichthyidae*)	Spaced snipe eel	*Avocettina gilli*
	Closespine snipe eel	*A. infans*
	Slender snipe eel	*Nemichthys scolopaceus*
Herrings (*Clupeidae*)	Pacific herring	*Clupea harengus pallasi*
	Pacific sardine (pilchard)	*Sardinops sagax*
Argentines (*Argentinidae*)	Bluethroat argentine	*Nansenia candida*
Deepsea smelt (*Bathylagidae*)	Stout blacksmelt	*Bathylagus milleri*
	Eared blacksmelt	*B. ochotensis*
	Slender blacksmelt	*B. pacificus*
	Northern smoothtongue	*Leuroglossus stilbius schmidti*

Pelagic Fish of Queen Charlotte Islands Offshore Waters (continued)
(from Anon 1983a after Hart 1973)

Family:	Species Name:	Scientific Name:
Spookfish (*Opisthoproctidae*)	Barreleye	*Macropinna microstoma*
Lightfish (*Gonostomatidaae*)	Veiled anglemouth	*Cyclothone microdon*
Scaleless dragonfish (*Melanostomiatidae*)	Longfin dragonfish	*Tactostoma macropus*
Viperfish (*Chauliodontidae*)	Pacific viperfish	*Chauliodus macouni*
Tubeshoulders (*Searsidae*)	Shining tubeshoulder	*Sagamichthys abei*
Lancetfish (*Alepisauridae*)	Longnose lancetfish	*Alepisaurus ferox*
Daggertooths (*Anotopteridae*)	Daggertooth	*Anotopterus pharao*
Pearleyes (*Scopelarchidae*)	Northern pearleye	*Benthalbella dentata*
Barracudinas (*Paralepididae*)	Slender barracudina	*Lestidum ringens*
Paperbones, wearyfish (*Scopelosauridae*)	Scaly wearyfish	*Scopelosaurus harryi*

Pelagic Fish of Queen Charlotte Islands Offshore Waters (continued)
(from Anon 1983a after Hart 1973)

Family:	Species Name:	Scientific Name:
Lanternfish (*Myctophidae*)	California headlightfish	*Diaphus theta*
	Pinpoint lampfish	*Lampanyctus regalis*
	Patchwork lampfish	*Notoscopelus resplendens*
	Bigeye lanternfish	*Protomyctophum thompsomi*
	Northern lampfish	*Stenobrachius leucopsarus*
	Bigfin lanternfish	*Symbolophorus californiense*
	Blue lanternfish	*Tarletonbeania crenularis*
Dreamers (*Oneirodidae*)	Spiny dreamer	*Oneirodes acanthias*
	Bulbous dreamer	*O. eschrichti*
Moras (*Moridae*)	Pacific flatnose	*Antimora microlepis*
Cuskpouts (*Derepodichthyidae*)	Cuskpout	*Derepodichthys alepidotus*
Grenadiers (*Macrouridae*)	Roughscale rattail	*Coryphaenoides acrolepis*
	Smoothscale rattail	*C. cyclolepis*
	Filamented ratail	*C. filifera*
	Bearded rattail	*C. liocephalus*
	Pectoral ratail	*C. pectoralis*
Sauries (*Scomberesocidae*)	Pacific saury	*Cololabis saira*
Melamphids (*Melamphaeidae*)	Highsnout melamphid	*Melamphaes lugubris*
	Crested melamphid	*Poromitra crassiceps*
Opahs (*Lamprididae*)	Opah	*Lampris regius*



Pelagic Fish of Queen Charlotte Islands Offshore Waters (continued)
(from Anon 1983a after Hart 1973)

Family:	Species Name :	Scientific Name:
Ribbonfish (*Trachipteridae*)	King-of-the-salmon	*Trachipterus altivelis*
Jacks (*Carangidae*)	Jack mackerel	*Trachurus symmetricus*
Pomfrets (*Bramidae*)	Pacific pomfret	*Brama japonica*
Manefish (*Carastiidae*)	Manefish	*Caristius macropus*
Armorheads (*Pentacerotidae*)	Pelagic armorheads	*Pentaceros richardson*
Barracudas (*Syphyraenidae*)	Pacific barracuda	*Sphyraena argentea*
Quillfish (*Ptilichthyidae*)	Quillfish	*Ptilichthys goodei*
Mackerels and Tunas (*Scombridae*)	mackerel Chub Albacore Bluefin tuna	*Scomber japonicus* *Thunnus alalunga* *T. thynnus*
Butterfish (*Stromateidae*)	Medusafish	*Icichthys lockingtoni*
Ragfish (*Icosteidae*)	Ragfish	*Icosteus aenigmaticus*

Some of the pelagic fish species, such as the tunas, opahs, pomfrets and some of the sharks, occur only occasionally in British Columbian waters as part of periodic northern migrations stimulated by warm water masses (Anon. 1983a). Though some of these (notably the albacore tuna, *Thunnus alalunga)* are taken commercially at that time, the most commercially important species remains the Pacific herring (*Clupea harengus pallasi*). Spawning along the shoreline in the intertidal and upper subtidal zones, on both coasts of the Queen Charlotte Islands and along the mainland coast, Pacific herring are purse-seined for their roe primarily in the Hecate Strait and form a major food item for other fish, seabirds, and marine mammals (Shields *et al.* 1985).

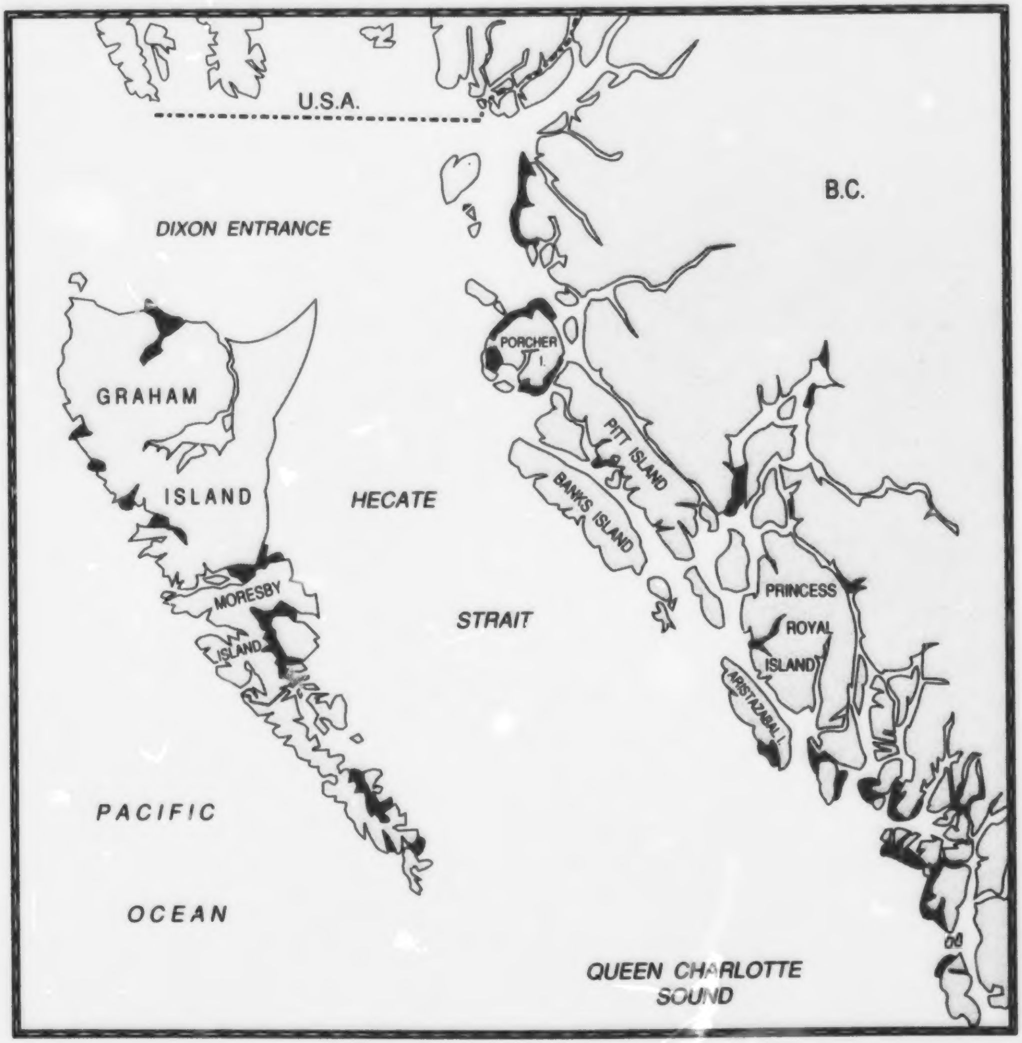

U.S.A.
B.C.
DIXON ENTRANCE
GRAHAM
ISLAND
HECATE
STRAIT
MORESBY
ISLAND
PORCHER I.
PITT ISLAND
BANKS ISLAND
PRINCESS ROYAL ISLAND
ARISTAZABAL I.
PACIFIC
OCEAN
QUEEN CHARLOTTE SOUND

Figure 149. Major herring spawning locations in the offshore Queen Charlotte Islands area. Boundaries are approximate (after Anon. 1978d)

One unusual aspect of the herring fishery is the spawn-on-kelp fishery, which is particularly active in the southern Queen Charlotte Islands. The adhesive eggs attach primarily to marine algae and sea grasses. The harvest of roe-on-kelp has been a traditional native fishery, and it has expanded into a commercial fishery following its introduction to Japan in the 1960's (Shields *et al.* 1985). Such is the profitability of the harvest, that fronds of *Macrocystis integrifolia* are now suspended on frames for the herring to spawn on, thereby simplifying the harvest and creating a more uniform product.

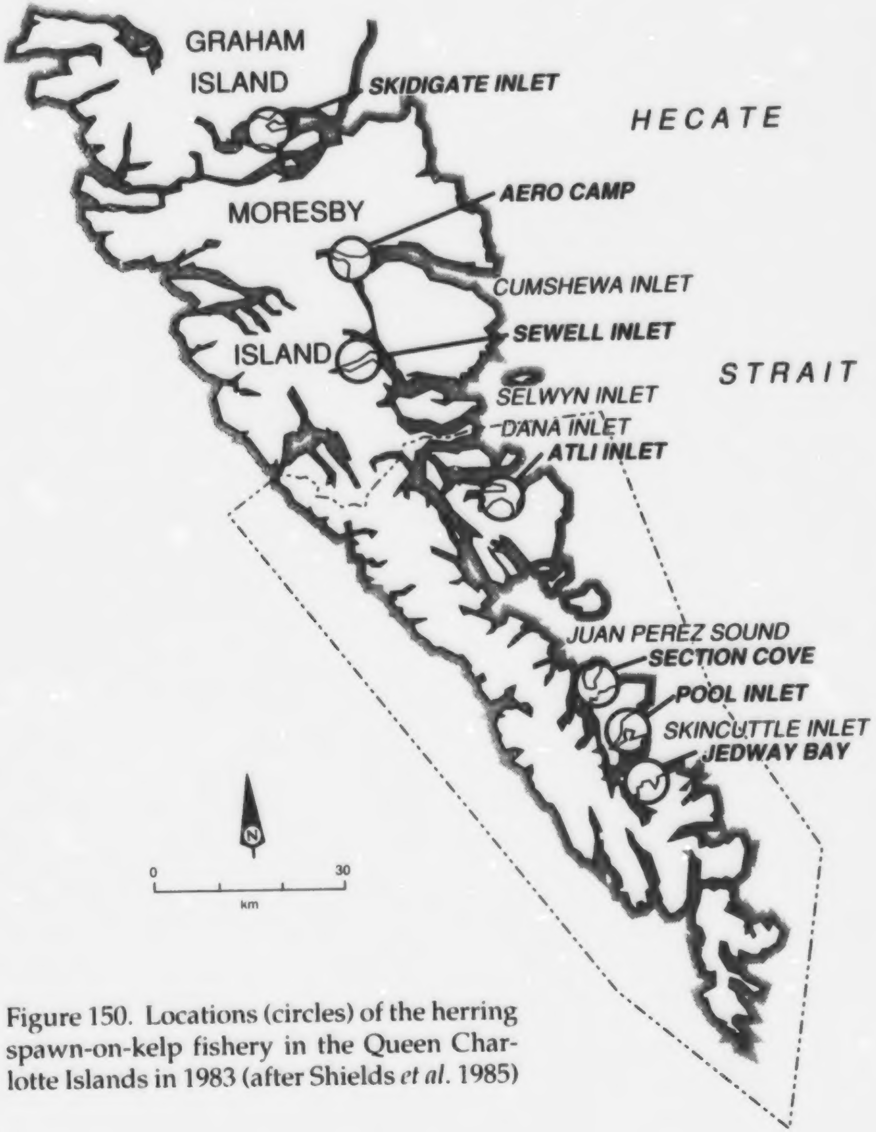

GRAHAM ISLAND
SKIDIGATE INLET
HECATE
AERO CAMP
MORESBY
CUMSHEWA INLET
SEWELL INLET
ISLAND
STRAIT
SELWYN INLET
DANA INLET
ATLI INLET
JUAN PEREZ SOUND
SECTION COVE
POOL INLET
SKINCUTTLE INLET
JEDWAY BAY
N
0
30
km

Figure 150. Locations (circles) of the herring spawn-on-kelp fishery in the Queen Charlotte Islands in 1983 (after Shields *et al.* 1985)

For the purposes of this study, the inshore fish species of the coastal marine waters of the Queen Charlotte Islands are those which live in nearshore areas throughout their lives. Species which are primarily anadromous, demersal or pelagic are discussed elsewhere. The majority of those species are bottom-dwelling, and as such their assemblages are affected by the bottom type and vegetation (Anon. 1983a). Hence, kelp bed, reef and estuarine habitats support distinctive fish communities. While few of the inshore fish species of the Queen Charlotte Islands region are taken commercially, a number are prey for important commercial species. The greenlings and flounder do contribute to both the sport and commercial fishery.

Fish of the Inshore Waters of the Queen Charlotte Islands (from Anon. 1983a, after Leaman 1980, Peden & Wilson 1976 and Hart 1973).

Family:	Species Name:	Scientific Name:
Toadfish (*Batrachoididae*)	Plainfin midshipman	*Porichthys notatus*
Clingfish (*Gobiesocidae*)	Northern clingfish	*Gobiesox maeandricus*
Cusk-eels and brotulas (*Ophidiidae*)	Red brotula	*Brosmophycis marginata*
Tube-snouts (*Aulorhynchidae*)	Tube-snout	*Aulorhynchus flavidus*
Sticklebacks (*Gasterosteidae*)	Threespine stickleback	*Gasterosteus aculeatus*
Pipefish (*Syngnathidae*)	Bay pipefish	*Syngnaths griseolineatus*
Drums (*Sciaenidae*)	White seabass	*Cynoscion nobilis*
Surfperches (*Embiotocidae*)	Shiner perch Striped seaperch Kelp perch Pile perch	*Cymatogaster aggregata* *Embiotoca lateralis* *Brachyistius frenatus* *Rhacochilus vacca*
Sandfish (*Trichodontidae*)	Pacific sandfish	*Trichodon trichodon*
Wrymouths (*Cryptacanthodidae*)	Giant wrymouth	*Delolepis gigantea*

Fish of the Inshore Waters of the Queen Charlotte Islands (continued)
(from Anon. 1983a, after Leaman 1980, Peden & Wilson 1976 and Hart 1973).

Family:	Species Name:	Scientific Name:
Ronquilis (*Bathymasteridae*)	Alaskan ronquil	*Bathymaster caeruleofasciatus*
	Searcher	*B. signatus*
	Northern ronquil	*Ronquilis jordani*
Pricklebacks (*Stichaeidae*)	Slender cockscomb	*Anoplarchus insignis*
	High cockscomb	*A. purpurescens*
	Pearly prickleback	*Bryozoichthys marjorius*
	Decorated warbonnet	*Chirolophis decoratus*
	Mosshead warbonnet	*C. nugator*
	Daubed shanny	*Lumpenus maculatus*
	Snake prickleback	*L. sagitta*
	Ribbon prickleback	*Phytichthys chirus*
	Arctic shanny	*Stichaeus puntatus*
	Whitebarred prickleback	*Poroclinus rothrocki*
	Black prickleback	*Xiphister autopurpureus*
	Rock prickleback	*X. mucosus*
Gunnels (*Pholidae*)	Penpoint gunnel	*Apodichthys flavidus*
	Longfin gunnel	*Pholis clemensi*
	Crescent gunnel	*P. laeta*
	Saddleback gunnel	*P. ornata*
	Red gunnel	*P. schultzi*
	Rockweed gunnel	*Xererpes fucorum*
Graveldivers (*Scytalinidae*)	Graveldiver	*Scytalina cerdale*
Sand lances (*Ammodytidae*)	Pacific sand lance	*Ammodytes hexapterus*
Gobies (*Gobiidae*)	Blackeye goby	*Coryphopterus nicholsi*
	Bay goby	*Lepidogobius lepidus*

Fish of the Inshore Waters of the Queen Charlotte Islands (continued) (from Anon. 1983a, after Leaman 1980, Peden & Wilson 1976 and Hart 1973).

Family:	Species Name:	Scientific Name:
Sculpins (*Cottidae*)	Scalyhead sculpin	*Artedius harringtoni*
	Smoothead sculpin	*A. literalis*
	Puget Sound sculpin	*A. meanyi*
	Rosylip sculpin	*Ascelichthys rhodorus*
	Spinynose sculpin	*Asemichthys taylori*
	Crested sculpin	*Blepsias bilobus*
	Silverspotted sculpin	*B. Cirrhosus*
	Roughback sculpin	*Chitonotus pugetensis*
	Sharpnose sculpin	*Clinocottus acuticeps*
	Calico sculpin	*C. embryum*
	Mosshead sculpin	*C. globiceps*
	Coastrange sculpin	*Cottus aleuticus*
	Buffalo sculpin	*Enophrys bison*
	Leister sculpin	*E. lucasi*
	Armourhead sculpin	*Gymnocanthus galeatus*
	Red Irish Lord	*Hemilepidotus hemilepidotus*
	Brown Irish Lord	*H. spinosus*
	Longfin sculpin	*Jordania zonope*
	Pacific staghorn sculpin	*Lepocottus armatus*
	Great sculpin	*Myoxocephalus polyacanthocephalus*
	Sailfin sculpin	*Nautichthys oculofasciatus*
	Tidepool sculpin	*Oligocottus maculosus*
	Saddleback sculpin	*O. rimensis*
	Fluffy sculpin	*O. snyderi*
	Grunt sculpin	*Rhamphocottus richardsoni*
	Cabezon	*Scorpaenichthys marmoratus*
	Manicled sculpin	*Synchirus gilli*

Fish of the Inshore Waters of the Queen Charlotte Islands (continued) (from Anon. 1983a, after Leaman 1980, Peden & Wilson 1976 and Hart 1973).

Family:	Species Name:	Scientific Name:
Greenlings	Kelp greenling	*Hexagrammos (Hexagrammidae) decagrammus*
	Rock greenling	*H. lagocephalus*
	Masked greenling	*H. octogrammus*
	Whitespotted grenling	*H. stelleri*
	Painted greenling	*Oxylebius pictus*
Poachers	Northern spearnose poacher	*Agonopsis emmelane*
	Sturgeon poacher	*Agonus aciepenserinus*
	Smooth alligatorfish	*Anoplagonus inermis*
	Rockhead	*Bothragonus swani*
	Fourhorn poacher	*Hypsagonus quadricornis*
	Pixie poacher	*Occella impi*
	Warty poacher	*O. verrucosa*
	Pygmy poacher	*Odontopyxis trispinosa*
	Tubenose poacher	*Pallasina barbata*
Lumpfish and Snailfish (*Cyclopteridae*)	Smooth lumpsucker	*Aptocyclus ventricosus*
	Pacific spiny lumpsucker	*Eumicrotremus orbis*
	Spotted snailfish	*Liparis callyodon*
	Ribbon snailfish	*L. cyclopus*
	Marbled snailfish	*L. dennyi*
	Tidepool snailfish	*L. florae*
	Slipskin snailfish	*L. fucensis*
	Slimy snailfish	*L. mucosus*
	Showy snailfish	*L. pulchellus*
	Ringtail snailfish	*L. rutteri*
	Lobefin snailfish	*Polypera greeni*
Lefteye Flounders (*Bothidae*)	Pacific sanddab	*Citharichthys sordidus*
	Speckled sanddab	*C. stigmaeus*
Righteye Flounders	Sand sole	*Psettichthys melanostictus*

Little as yet is known of the status and geographic range of non-commercial endemic, rare or endangered species of the offshore waters of the Queen Charlotte Islands (Anon. 1983a). The Cuskpout (*Derepodichthys alepidotus*), smoothscale rattail (*Coryphaenoides cyclolepis*), filamented rattail (*C. filifera*), and pixie poacher (*Occella impi*) are endemic to the region. Some species (such as certain tuna and greenling) are locally rare only by virtue of the fact that they are at the northern or southern limit of their range. There is no reason to believe that ranges of other fish species of the eastern Pacific will not be extended into the study region as more survey work such as the 1974 work by Peden & Wilson (1976) is completed. That Peden and Wilson were able to extend the known geographic ranges of 20 percent of the species which they collected on what they described as a modest expedition, emphasizes just how under-studied the region is. Many additions to the midwater fishes of the British Columbia coast continue to be due to chance capture.

Rare and Endemic Species of the Queen Charlotte Islands Offshore Waters (from Anon 1983a, after Hart 1973 and Peden & Wilson 1976)

Family:	Species Name:	Scientific Name:
Cuskpouts (*Derepodichthyidae*)	Cuskpout*	*Derepodichthys alepidotus*
Grenadiers (*Macrouridae*)	Smoothscale rattail** Filamented rattail*	*Coryphaenoides cyclolepis* *C. filifera*
Ronquils (*Bathymasteridae*)	Alaskan ronquil	*Bathymaster caeruleofasciatus*
Pricklebacks (*Stichaeidae*)	Arctic shanny	*Stichaeus punctatus*
Rockfish (*Scorpaenidae*)	Dusky rockfish	*Sebastes ciliatus*
Sculpins (*Cottidae*)	Leister sculpin Armourhead sculpin Bigmouth sculpin Horny sculpin	*Enophyrys lucasi* *Gymnocanthus galeatus* *Hemitripterus bolini* *Icelus spiniger* *Myoxocephalus sp.* (description pending)
Greenlings (*Hexagrammidae*)	Masked greenling	*Hexagrammos octogrammus*
Poachers (*Agonidae*)	Pixie poacher*	*Occella impi*

*single record only, **two records only.

-Herpetiles

Both the reptiles and amphibians of the Queen Charlotte Islands have been little studied. Within the marine environment, the only known herpetile is a reptile, the Pacific leatherback turtle, *Dermochelys coriacea schlegeli*, one of the two subspecies of the leatherback turtle, the world's largest turtle (Gregory & Campbell 1984). Totally marine in habitat, the leatherback is primarily a creature of the tropics and subtropics, though it ranges farther north and south than any other marine turtle. Gregory & Campbell (1984) record sightings of the Pacific leatherback at 14 points along the British Columbia coast, four of those in the coastal waters of the Queen Charlotte Islands. The number of records may not be related to the frequency of occurrence of the turtles in the region so much as it is to the paucity of observations.

The two amphibians known to inhabit the Queen Charlotte Islands, the western toad (*Bufo boreas*) and the Pacific treefrog (*Hyla regilla*), are primarily creatures of the freshwater and terrestrial environments rather than the marine environment.

-Marine Avifauna

While about 50 species of marine birds have been recorded on and around the Queen Charlotte Islands, only about 22 species of sea or shore birds are known or believed to nest in the area (Cowan, 1989). The majority of those birds are seabirds rather than shorebirds, and of the seabirds, the greater number are burrow-nesters.

Marine Breeding Birds of the Queen Charlotte Islands
(after Cowan 1989, Godfrey 1986)

Family:	Species Name:	Scientific Name:
Loons (*Gaviidae*)	Common Loon Red-throated Loon	*Gavia immer* *Gavia stellata*
Storm-petrels (*Hydrobatidae*)	Fork-tailed Storm-Petrel	*Oceanodroma furcata plumbea*
	Leach's Storm-Petrel	*Oceanodroma leucorhoa beali*
Cormorants (*Phalacrocoracidae*)	Pelagic Cormorant	*Phalacrocorax pelagicus pelagicus*
Sandpipers, Phalaropes, and Allies (*Scolopacidae*)	Spotted Sandpiper Least Sandpiper Short-billed Dowitcher Common Snipe	*Actitis macularia* *Calidris minutilla* *Limnodromus griseus* *Gallinago gallinago delicata*
Plovers	Semipalmated Plover	*Charadrius semipalmatus*
(*Charadriidae*)	Killdeer	*Charadrius vociferus vociferus*
Oystercatchers (*Haematopodidae*)	Black Oystercatcher	*Haematopus bachmani*

The relatively small number of marine bird species belies the importance of the Queen Charlotte Islands as the major nesting ground in Canada for marine birds of the northeast Pacific Ocean (Cowan 1989). The Environmental Protection Service (Anon. 1978h) has identified the area as being both important and sensitive as habitat for marine-associated birds, both in the winter and summer.

Marine Breeding Birds of the Queen Charlotte Islands (continued)
(after Cowan 1989, Godfrey 1986)

Family:	Species Name:	Scientific Name:
Skuas, Gulls, Terns, and Skimmers (*Laridae*)	Glaucous-winged Gull	*Larus glaucescens*
Auks, Murres, and Puffins (*Alcidae*)	Common Murre	*Uria aalge inornata*
	Thick-billed Murre*	*Uria lomvia arra*
	Pigeon Guillemot	*Cepphus columba columba*
	Marbled Murrelet	*Brachyramphus marmoratus marmoratus*
	Ancient Murrelet	*Synthliboramphus antiquus*
	Cassin's Auklet	*Ptychoramphus aleuticus aleuticus*
	Rhinoceros Auklet	*Cerorhinca monocerata*
	Tufted Puffin	*Fractercula cirrhata*
	Horned Puffin	*Fractercula corniculata*

*Unconfirmed: The species nests on Triangle Island. Cowan (1989) assumes that its breeding range now extends to the Queen Charlotte Islands.

RATING SYSTEM: **Large number** - *sensitivity rating* = sum of the following three values (in brackets on the map). Estimates are general, based on best data.

First number - *abundance of birds*

rating	breeding individuals	birds/km of coast
5	>500,000	>125
4	100,001 - 500,000	80 - 125
3	50,001 - 100,000	45 - 79
2	10,000 - 50,000	20 - 44
1	<10,000	<20

Second number - *sensitivity to oil spills*

rating	species
5	alcids, seaducks
4	storm petrols, phalaropes, brant
3	loons, grebes, cormorants, kittiwakes
2	bald eagles, swans, diving ducks, shearwaters
1	gulls, dabbling ducks, snow geese, Canada geese

Third number - *importance of individual concentrations of species in relation to the total coastal population of that species*

rating	importance of concentration
5	high
3	medium
1	low

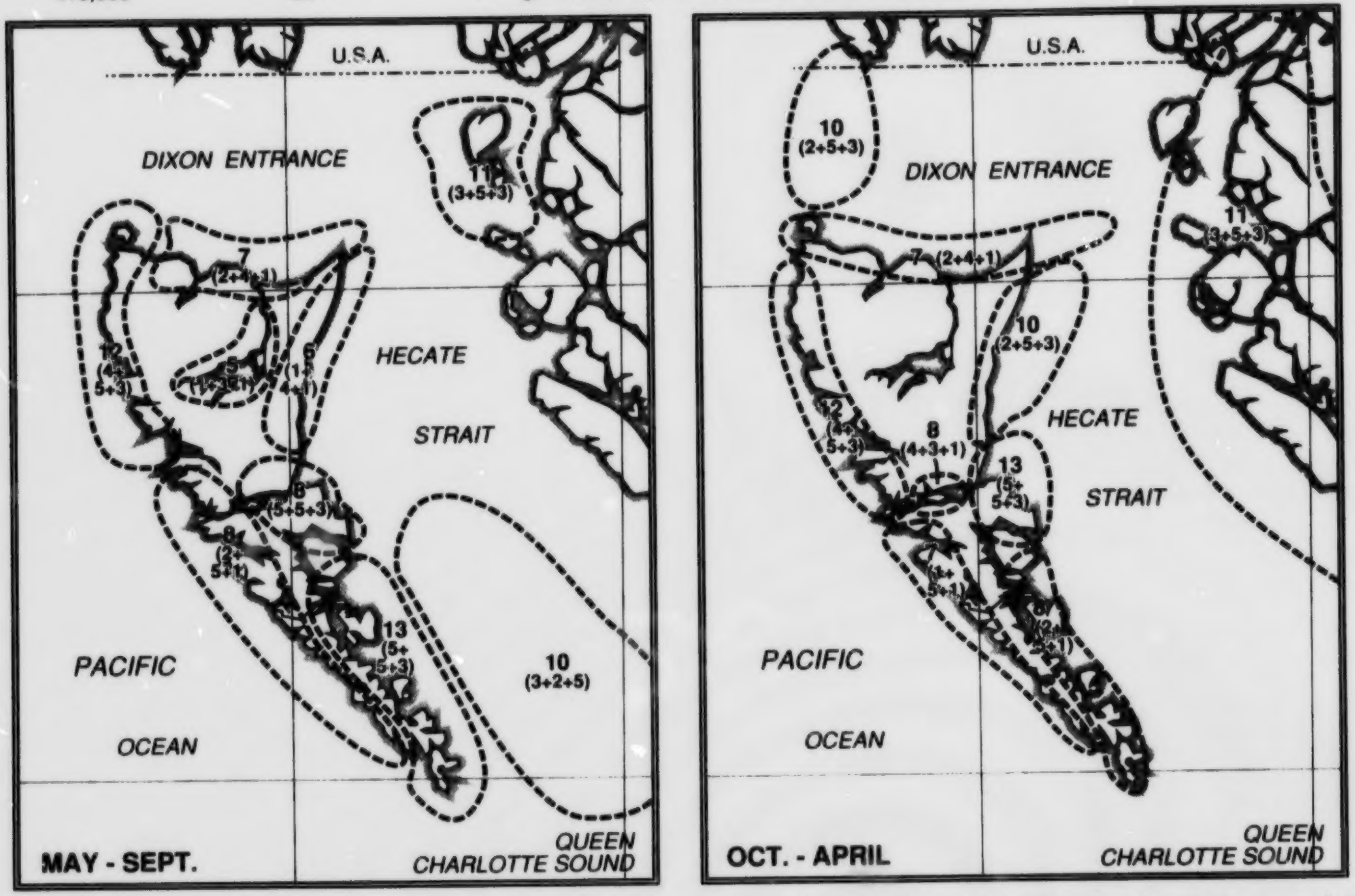

U.S.A.
DIXON ENTRANCE
11 (3+5+3)
7 (2+4+1)
12 (4+5+3)
5 (1+3+1)
6 (1+4+1)
HECATE
STRAIT
8 (5+5+3)
8 (2+5+1)
13 (5+5+3)
10 (3+2+5)
PACIFIC
OCEAN
QUEEN CHARLOTTE SOUND
MAY - SEPT.
U.S.A.
10 (2+5+3)
DIXON ENTRANCE
11 (3+5+3)
7 (2+4+1)
10 (2+5+3)
12 (4+5+3)
8 (4+3+1)
13 (5+5+3)
HECATE
STRAIT
7 (1+5+1)
8 (2+5+1)
PACIFIC
OCEAN
QUEEN CHARLOTTE SOUND
OCT. - APRIL

Figure 151. Abundance, sensitivity and importance of marine birds of the Queen Charlotte Islands (after Rodway *et al.* 1988)

In the case of seabirds alone, there are over 1.5 million birds of 12 different species breeding annually at almost 200 sites in the archipelago (Rodway *et al.* 1988). Two storm-petrels (*Oceanodroma* spp.), the pelagic cormorant (*Phalacrocorax pelagicus*), the glaucous-winged gull (*Larus glaucescens*) and six alcids (family Alcidae) breed in both the Graham and Moresby Island groups, while the common murre and the horned puffin breed in the Moresby Island group alone. Of those numbers, about 500,000 birds of 10 species nest at 78 sites on the east coast of Moresby Island.

The west and south coasts of Moresby Island are home to all 12 species of seabirds known to nest in the Queen Charlotte Islands. Nearly 500,000 seabirds live at 32 colonies from the Kerouard Islands to Skidegate Channel. Of the rhinoceros auklets (*Cerorhinca monocerata*) breeding in the Queen Charlotte Islands, 93 percent of their number nest on the west and south coasts of Moresby Island. Large parts of the storm-petrel, Cassin's auklet (*Ptychoramphus aleuticus*) and tufted puffin (*Fractercula cirrhata*) populations are found there as well (Summers & Rodway 1988).

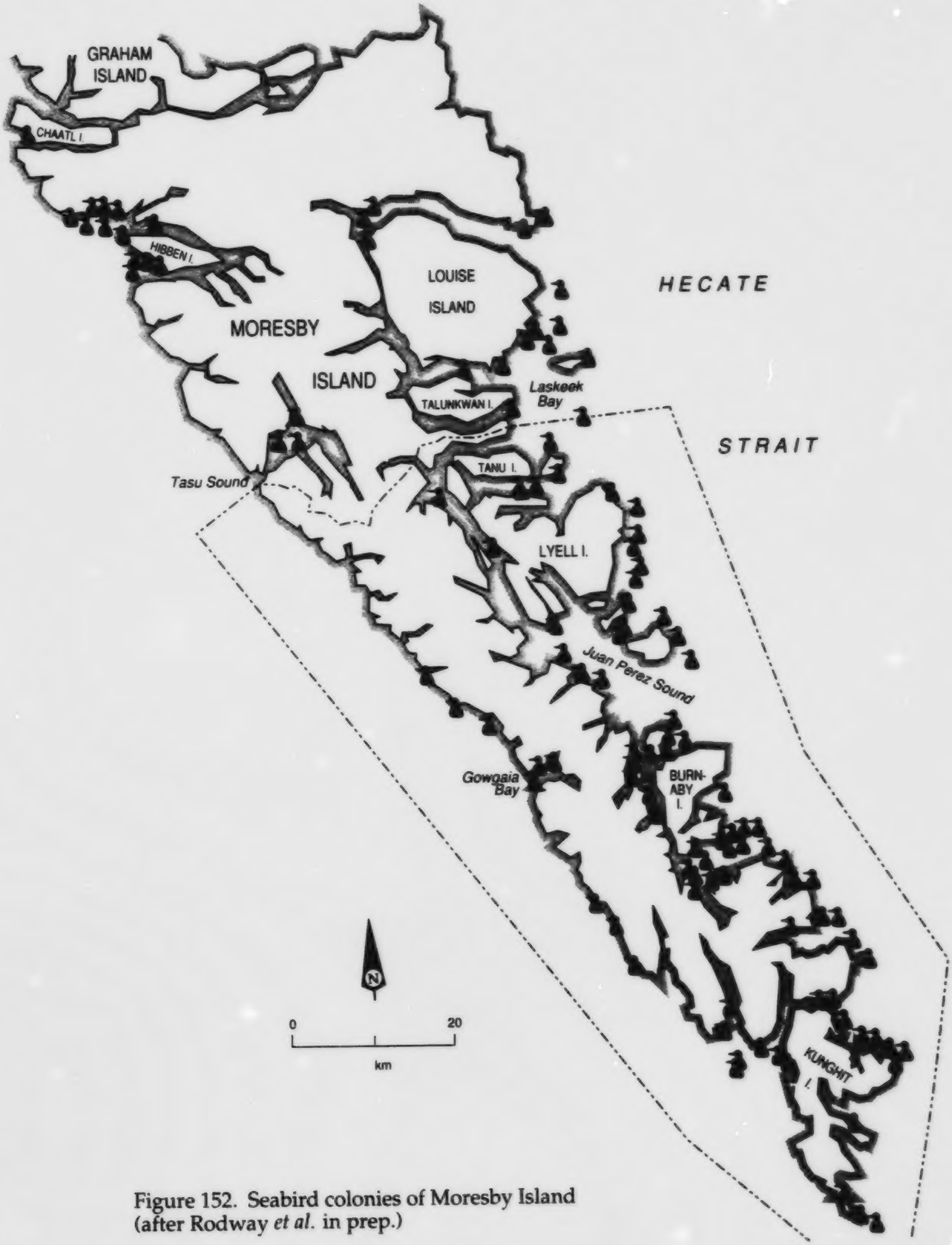

GRAHAM ISLAND
CHAATL I.
HIBBEN I.
MORESBY ISLAND
LOUISE ISLAND
HECATE STRAIT
Laskeek Bay
TALUNKWAN I.
TANU I.
Tasu Sound
LYELL I.
Juan Perez Sound
Gowgaia Bay
BURN-ABY I.
KUNGHIT I.
N
0
20
km

Figure 152. Seabird colonies of Moresby Island (after Rodway *et al.* in prep.)

By virtue of the adjacent marine staging areas, some seabird colonies extend into the marine environment. The behaviour known as staging is a characteristic of the burrow-nesting seabirds of the region whereby the birds congregate on the water at dusk adjacent to their nesting colonies prior to making their way to the land.

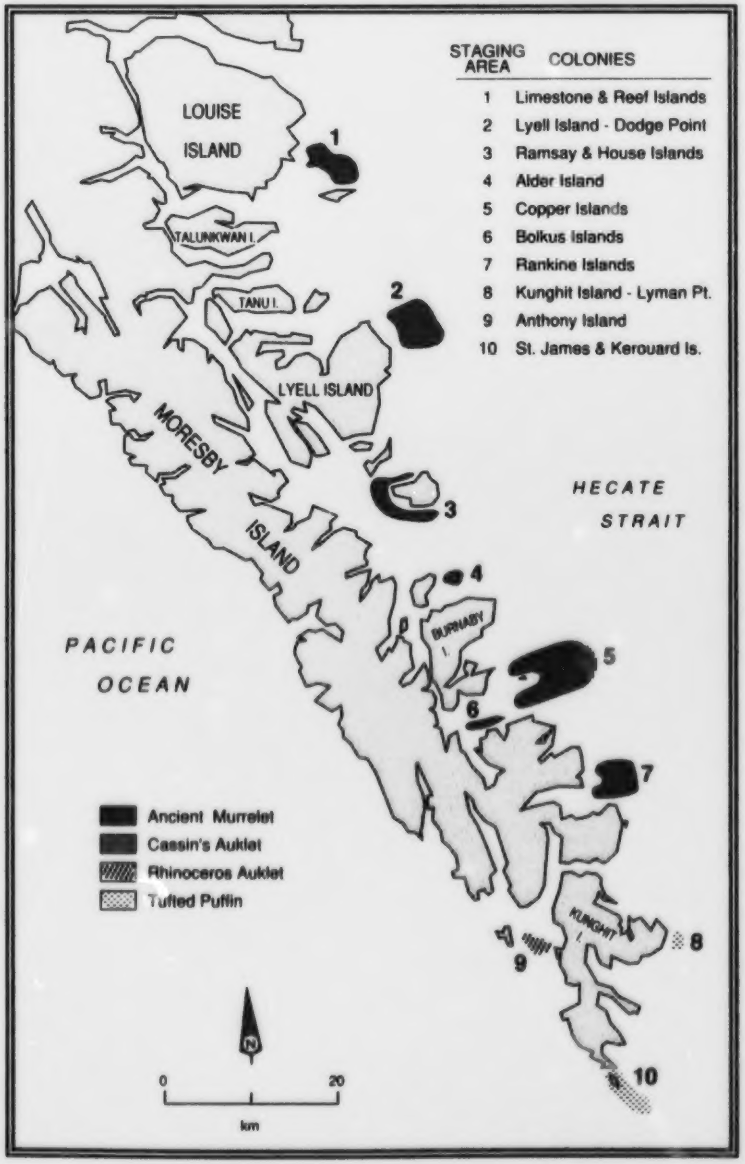

STAGING AREA
COLONIES
1 Limestone & Reef Islands
2 Lyell Island - Dodge Point
3 Ramsay & House Islands
4 Alder Island
5 Copper Islands
6 Bolkus Islands
7 Rankine Islands
8 Kunghit Island - Lyman Pt.
9 Anthony Island
10 St. James & Kerouard Is.
LOUISE ISLAND
TALUNKWAN I.
TANU I.
LYELL ISLAND
MORESBY ISLAND
BURNABY I.
KUNGHIT I.
HECATE STRAIT
PACIFIC OCEAN
Ancient Murrelet
Cassin's Auklet
Rhinoceros Auklet
Tufted Puffin
N
0
20
km
1
2
3
4
5
6
7
8
9
10

Figure 153. Major staging areas of nesting seabirds on the south and east coast of Moresby Island (after Rodway *et al.* 1988 and in prep.)

South Moresby/Gwaii Haanas National Park Reserve provides breeding grounds for about 43 percent of the seabird population (Bertram 1989). The region is particularly important to certain populations. Fully 44 percent of the ancient murrelet (*Synthiboramphus antiquus*) population of British Columbia, along with a significant percentage of the storm-petrels, pigeon guillemots (*Cepphus columba*) and Cassin's auklets, nest in the Queen Charlotte Island archipelago (Rodway *et al.* in prep.).

Among the seabirds, there are other than breeding species which can be seen in the region. Passage migrants, including the jaegers (*Stercorarius* spp.), terns (subfamily *Sterninae*), phalaropes (*Phalaropus* spp.) and some of the gulls (subfamily *Larinae*) stop over in the Queen Charlotte Islands in large numbers in the spring and fall during annual migrations (Campbell 1984). A further twelve species are visitors which spend the breeding season elsewhere. All of the waterfowl noted in the Terrrestrial Wildlife Resources Section may make use of the marine environment from time to time, though their principal habitat is fresh water. Neither do they breed in the marine environment.

Seabirds in particular are known to be important food sources for raptors. The bald eagle and peregrine falcon are both known to prey on seabirds. A measure of the richness of the habitat for the bald eagle is the fact that the Queen Charlotte Islands are the only area where the bird is known to fledge up to three young at once (Campbell 1984). Moreover, the shoreline of south Moresby Island supports more eagle nests per kilometre of shoreline than anywhere else in Canada. The population in the Queen Charlotte Islands archipelago is estimated to be in the low hundreds. Though fish are the major part of the diet of the bald eagle, the peregrine falcon preys solely on birds, often only on marine birds. The decline of seabird populations in the Queen Charlotte Islands may be responsible for a decline in peregrine falcon numbers in the area (Bertram 1989). Every active falcon eyrie is located close to a seabird colony, and when seabird colony populations decline or when the colony moves to a new location, so do the peregrine falcons (Campbell 1984). Nonetheless, the Queen Charlotte Islands are home to the highest breeding densities for falcons anywhere in the world. The total population of peregrine falcons in 1980 was estimated at 230.

There are in fact no nesting colonies of seabirds on either Graham or Moresby Islands proper, though Langara Island (4.5 hectares in size) and Kunghit Island (33.2 hectares in size), two of the larger minor islands in the group, do support colonies (Campbell & Garrioch 1979). Most of the major bird colonies are separated from the largest islands, which may be due to the avoidance of mammalian predators by ground-nesting seabirds (Cowan 1989). Predation by raccoon (*Procyon lotor vancouverensis*), Alexandrian rat (*Rattus rattus alexandrinus*), and marten (*Martes americana nesophila*) have contributed to population declines and even colony extinctions amongst nesting seabirds (Summers & Rodway 1988).

-Marine Mammals

Of the 33 species of marine mammals known or expected to occur in British Columbian waters (up to 320 kilometres offshore, the limit of the Canadian extended economic zone), three species, the pigmy sperm whale (*Kogia breviceps*), the bottlenose dolphin (*Tursiops truncatus*), and the ribbon seal (*Phoca fasciata*), are hypothetical, having been recorded in American waters to the south (Baird & Stacey 1989). The bias of the sighting effort in British Columbia is towards the summer and towards southern waters. At least 26 species are known or expected to occur in the area of the Queen Charlotte Islands, of which 3 species are unconfirmed. The mink (*Mustela vison energumenos*) is arguably an additional marine mammal of record, since its feeding habitat within the study area is primarily intertidal and it swims regularly from island to island to hunt and mate, but its predominant habitat in Canada is terrestrial.

A variety of cetacea are found in the area of the Queen Charlotte Islands. Between 1911 and 1943, two whaling stations operated at Rose Harbour and Naden Harbour in the Queen Charlotte Islands, processing 8,353 whales, primarily sperm whales (*Physeter macrocephalus*) and rorqual (family *Balaenopteridae*) species (Pike & MacAskie 1969). The use of sperm whales over the years showed a steady increase as the use of other whales declined.

Marine Mammals of British Columbia
Species known within the area of the Queen Charlotte Islands are in bold face (after Baird & Stacey 1989, Banfield 1977, Anon. 1983a).

ORDER and Family:	Species Name:	Scientific Name:
CETACEANS (CETACEA)		
Beaked Whales (*Ziphiidae*)	**Baird's Beaked Whale**	*Berardius bairdii*
	Stejneger's Beaked Whale	*Mesoplodon stejnegeri*
	Hubbs' Beaked Whale	*Mesoplodon carlhubbsi*
	Cuvier's Beaked Whale	*Ziphus cavirostris*
Sperm Whales (*Physeteridae*)	**Sperm Whale**	*Physeter macrocephalus*
Pigmy Sperm Whales (*Kogiidae*)	Pygmy Sperm Whale*	*Kogia breviceps*
	Dwarf Sperm Whale	*Kogia simus*
Dolphins and Porpoises (*Delphinidae*)	Striped Dolphin	*Stenella coeruleoalba euphrosyne*
	Common Dolphin	*Delphinus delphis bairdii*
	Bottlenose Dolphin*	*Tursiops truncatus truncatus*
	Northern Right-Whale Dolphin	*Lissodelphis borealis*
	Pacific White-Sided Dolphin	*Lagenorhynchus obliquidens*
	Killer Whale	*Orcinus orca*
	False Killer Whale	*Pseudorca crassidens*
	Risso's Dolphin	*Grampus griseus*
	Short-Finned Pilot Whale	*Globicephala macrorhynchus*
	Harbour Porpoise	*Phocoena phocoena*
	Dall's Porpoise	*Phocoenoides dalli*

*unconfirmed species

Marine Mammals of British Columbia (continued)
Species known within the area of the Queen Charlotte Islands are in bold face
(after Baird & Stacey 1989, Banfield 1977, Anon. 1983a).

ORDER and Family:	Species Name:	Scientific Name:
Gray Whales (*Eschrichtidae*)	**Gray Whale**	*Eschrichtius robustus*
Rorquals (*Balaenopteridae*)	**Fin Whale**	*Balaenoptera physalus physalus*
	Sei Whale	*Balaenoptera borealis*
	Minke Whale	*Balaenoptera acutorostrata davidsonii*
	Blue Whale	*Balaenoptera musculus*
	Humpback Whale	*Megaptera novaeangliae*
Bowhead Whales (*Balaenidae*)	**Right Whale**	*Eubalaena glacialis japonica*
CARNIVORES (*CARNIVORA*)		
Weasels and Allies (*Mustelidae*)	**River Otter**	*Lutra canadensis periclyzomae*
	Sea Otter	*Enhydra lutris lutris*
PINNIPEDS (*PINNIPEDIA*)		
Eared Seals (*Otariidae*)	**Steller Sea Lion**	*Eumetopias jubatus*
	California Sea Lion	*Zalophus californianus californianus*
	Northern Fur Seal	*Callorhinus ursinus*
True Seals (*Phocidae*)	**Harbour Seal**	*Phoca vitulina richardii*
	Ribbon Seal*	*Phoca fasciata*
	Elephant Seal	*Mirounga angustirostris*

*Unconfirmed species: Baird & Stacey (1989) note records from adjacent waters.

Those whales with teeth (suborder *Odontoceti*), the beaked whales, sperm whales, dolphin and porpoises, feed mainly on fish and squid, though the killer whale (*Orcinus orca*) will also take otters, seals, sea lions and other whales (Anon. 1983a). Little is known of the distribution and abundance of the beaked whales, most of which travel the coast in small pods, though a school of Baird's beaked whale can be as large as 30 individuals (Nishiwaki 1967). Of the sperm whales, only solitary males are found in the waters of the Queen Charlotte Islands, usually offshore (Nishiwaki 1967, Pike & MacAskie 1969). Dolphins and porpoises are among the most recognizeable cetaceans in the region. The Pacific white-sided dolphin is common offshore in herds of about 200 (Leatherwood & Reeves 1978), though uncommon inshore (Baird & Stacey 1989). Risso's dolphin is often found in the company of the Pacific white-sided dolphin (Leatherwood & Reeves 1978) though sightings for it are rare year-round (Baird & Stacey 1989). The short-finned pilot whale (*Globicephala macrorhynchus*) has been recorded only 19 times in British Columbian waters in 18 locations, few of those in the study area (Baird & Stacey in press).

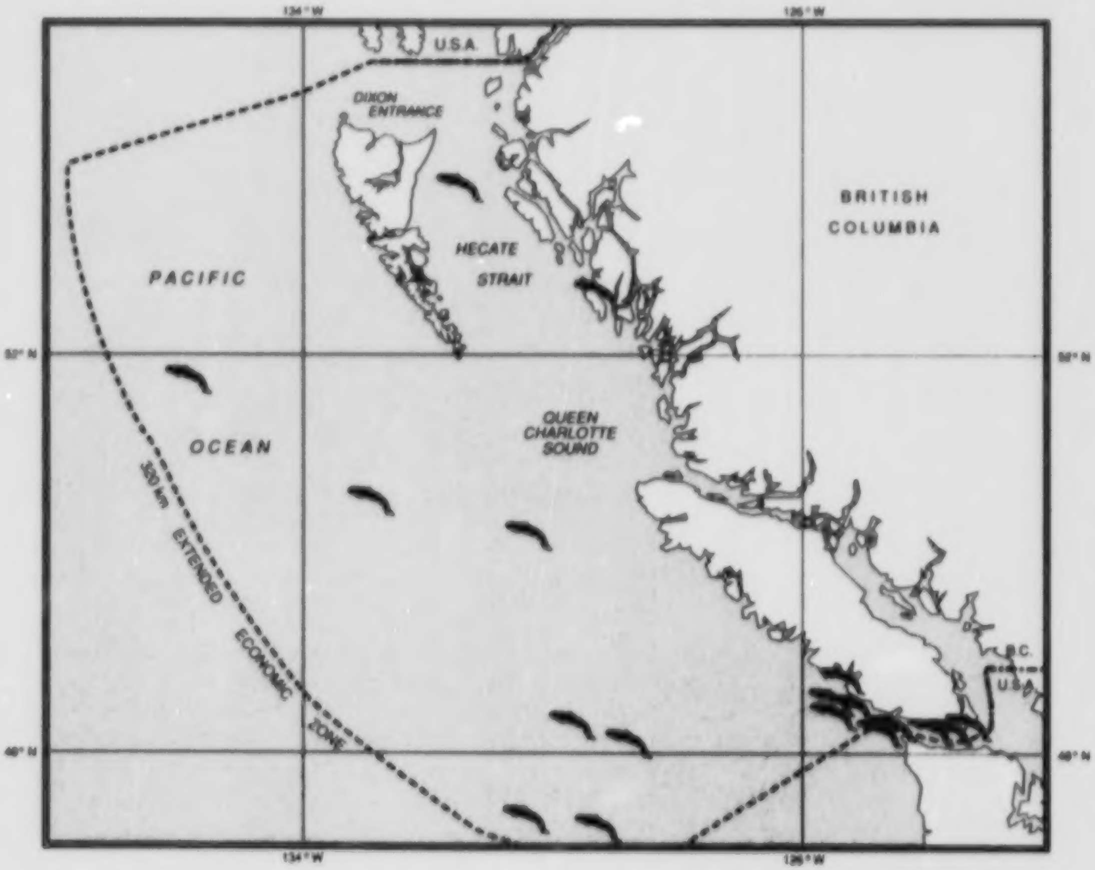


Figure 154. Localities of records of short-finned pilot whales (*Globicephala macrorhynchus*) from within the B.C. 320 kilometre (200 mile) extended economic zone (after Baird & Stacey in prep.)

Killer whales are common year-round in the area (Baird & Stacey 1989) and include numerous transients as well as three resident pods (Denning 1984). The population for the coast of British Columbia and Washington consists of about 250 resident whales and about 80 transient individuals. The residents are found in pods of 5 to 50 individuals each in a northern community and a southern community. The northern community ranges from mid-Vancouver Island north to the southeastern tip of Alaska, and the southern community extends from about mid-Vancouver Island south into the Gulf of Georgia, Puget Sound, the Straits of Juan de Fuca and down the west coast of Washington to about Grays Harbour. Transient pods of 1 to 7 individuals range throughout Washington and British Columbian coastal waters and even up into southeastern Alaskan waters (Bigg *et al.* 1987).

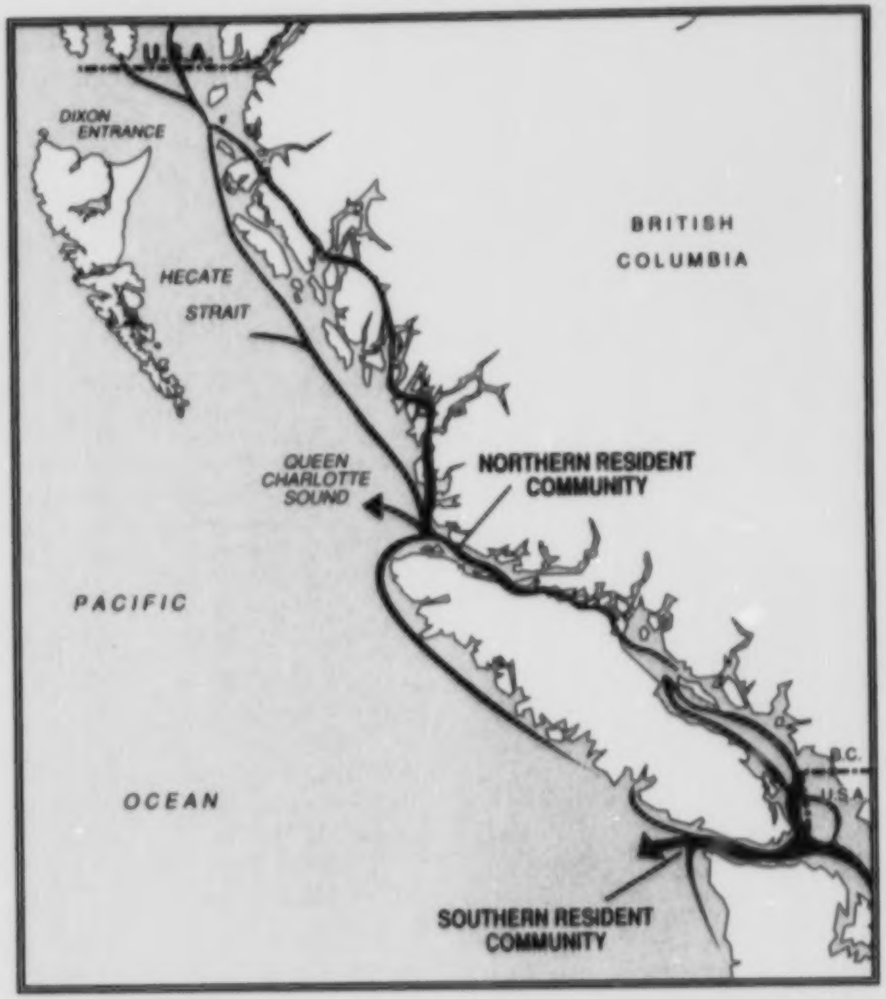

U.S.A.
DIXON ENTRANCE
HECATE STRAIT
BRITISH COLUMBIA
QUEEN CHARLOTTE SOUND
NORTHERN RESIDENT COMMUNITY
PACIFIC
OCEAN
B.C.
U.S.A.
SOUTHERN RESIDENT COMMUNITY

Figure 155. Main travel routes of the northern and southern resident communities of killer whale *(Orinchus orca)* in British Columbia (after Bigg *et al.* 1987)

Both the Dall's porpoise (*Phocoenoides dalli*) and the harbour porpoise (*Phocoena phocoena*) are common throughout the year in the vicinity of the Queen Charlotte Islands (Baird & Stacey 1989). The Dall's porpoise is both the most abundant and the most widespread of the two, occurring both inshore and up to 2,400 kilometres offshore, while the harbour porpoise commonly occurs in small groups in waters only up to 32 metres from shore (Leatherwood & Reeves 1978). Groups of 30 to 100 individuals of Dall's porpoise are not uncommon in nearshore waters during the spring and fall migrations (Anon 1983a).

The baleen whales (suborder *Mysticeti*), including the grey whales, the rorquals and the bowhead whales, feed by skimming or swallowing small fish and crustaceans either at the surface or along the bottom. Six species of baleen whales are expected annually in British Columbian waters in varying numbers: gray whales (*Eschirchtius robustus*), fin whales (*Balaenoptera physalus physalus*), sei whales (*Balaenoptera borealis*), minke whales (*Balaenoptera acutorostrata davidsonii*), blue whales (*Balaenoptera musculus*), and humpback whales (*Megaptera novaeangliae*). A seventh species, the right whale (*Eubalaena glacialis japonica*), is regarded as a vagrant, unexpected annually, but for which there are more than five B.C. records (Baird & Stacey 1989). The right whale is a rare species in any case, the world population amounting to only 100-200 individuals (Gilmore 1978).

The gray whale, though extirpated in the Atlantic, may be recovering in the eastern Pacific to historical population numbers of 15,000 individuals or more (Reeves & Mitchell 1988). Virtually the whole of that population migrates northward along the west coast of the Queen Charlotte Islands from late March to June each year, returning south between October and February (Pike & MacAskie 1969, Darling 1977). It is during the northward migration that the gray whales stop to feed in British Columbian waters, and 35 to 50 of those animals may spend the duration of the summer in our coastal waters in any one year (Pike & MacAskie 1969, Murison *et al.* 1984).

Fin, sei, and blue whales are found in both the offshore and nearshore waters of the Queen Charlotte Islands, but are most frequent in western Dixon Entrance and Queen Charlotte Sound (Anon 1983a). Estimates of the north Pacific populations are 17,000 fin whales (Pike & MacAskie 1969), 14,000 sei whales (Allen 1980) and 1,500 blue whales (Rice 1974). The fin whales are best known, travelling in groups of 3-20 on their spring and fall migrations and sometimes living in the Queen Charlotte Islands vicinity for the summer (Pike & MacAskie 1969). Minke and humpback whales, like the gray whale, are more commonly seen in the nearshore waters (Pike & MacAskie 1969, Mitchell 1978). Estimates of the north Pacific popultions are 75,000 minke whales and 1,400 humpback whales (Allen 1980).

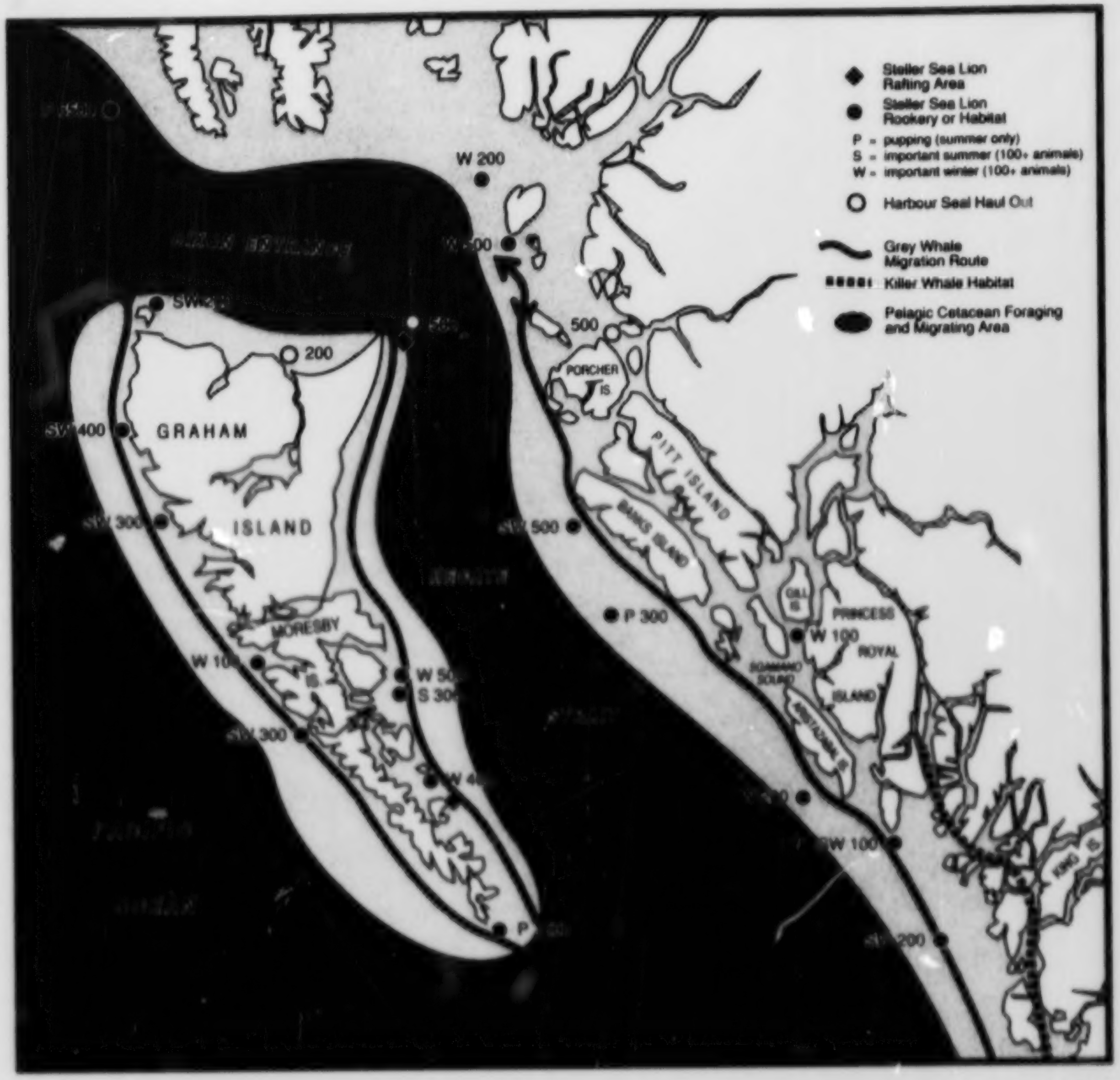

Steller Sea Lion Rafting Area
Steller Sea Lion Rookery or Habitat
P = pupping (summer only)
S = important summer (100+ animals)
W = important winter (100+ animals)
Harbour Seal Haul Out
Grey Whale Migration Route
Killer Whale Habitat
Pelagic Cetacean Foraging and Migrating Area
GRAHAM
ISLAND
MORESBY
IS.
PORCHER IS
PITT ISLAND
BANKS ISLAND
PRINCESS
ROYAL
ISLAND
GIL IS
ESTEVAN IS
KING IS
W 200
W 500
500
200
SW 400
SW 300
W 100
SW 300
W 50
S 300
W 40
P
SW 500
P 300
W 100
SW 100
SW 200

Figure 156. Some important marine animals of the Queen Charlotte Islands area. Numbers represent populations. (after Anon. 1978, Anon. 1983a, Bigg 1985)

The pinnipeds of the Queen Charlotte Islands region include the Steller sea lion (*Eumetopias jubatus*), the northern fur seal (*Callorhinus ursinus*), the harbour seal (*Phoca vitulina richardii*), and the elephant seal (*Mirounga angustirostris*). Possible additions include the California sea lion (*Zalophus californianus californianus*) and the ribbon seal (*Phoca fasciata*), both of which occur in waters to the south (Baird & Stacey 1989).

Steller sea lions are common residents of inshore waters in the Queen Charlotte Islands year-round (Baird & Stacey 1989). The animals occupy a variety of sites used as rookeries, year-round haulouts, winter haulouts and winter rafting areas (Bigg 1985, 1988a). Rookeries are exposed sites where breeding and births take place and are occupied year-round, though the population swells in the summer when males join the cows and young of the year. There are only three sites in British Columbia currently used as rookeries, all of which are in the vicinity of the Queen Charlotte Islands. In southern Queen Charlotte Sound, off the northern tip of Vancouver Island, are Triangle Island, Sartine Island, and Beresford Island. In central western Hecate Strait is Danger Rocks. And at Cape St. James is the only rookery in South Moresby/Gwaii Haanas National Park Reserve on the Kerouard Islands. The South Moresby rookery is the largest sea lion rookery on the Pacific coast of North America, with some 800 animals hauling out each breeding season to give birth to about 300 pups (Denning 1984). Haulouts are exposed sites, adjacent to land masses, where births and breeding are rare (Bigg 1985). Main occupancy may be only in the winter, or animals may be present year-round. A number of such sites are located in the Queen Charlotte Islands area. Winter rafting areas are locations mainly close to shore where, in the absence of suitable haulouts, sea lions rest on the water surface in tight groups. Two such locations are presently known in the Queen Charlotte Islands, one off Rose Point and one off Burnaby Island.

Amongst the other pinnipeds, neither the northern fur seal nor the elephant seal breed in British Columbia, though the northern fur seal is common in offshore areas year-round, with the largest numbers occurring January through June during the northward migration to the Bering Sea (Baird & Stacey 1989). The elephant seal is an unusual sighting year-round in British Columbian waters. The harbour seal is common year-round in British Columbia as an inshore resident (Baird & Stacey 1989), foraging in shallow, nearshore waters. The 1969 estimate of the British Columbian population was 35,000 individuals (Bigg 1969). An abundant food source and ideal habitat have enabled the harbour seal population numbers to remain consistently high at South Moresby Island (Denning 1984).

The only two marine carnivores found in the Queen Charlotte Islands are the river otter and the sea otter. The river otter is common inshore year-round along the British Columbian coast (Baird & Stacey 1989), and its numbers are abundant in South Moresby where it forages in shallow seas and along the shoreline (Denning 1984). It is often mistaken for the sea otter, which was once abundant (between 5,000 and 10,000 animals in 1780) in the Queen Charlotte Islands, but had been hunted to extinction by 1920 (Denning 1984). There are only two recorded sightings of sea otters on South Moresby since that time, one at Cape St. James (Edie 1973) and one in Flamingo Inlet, opposite Sperm Bay (Taylor & Gough 1977). There was an an attempt to re-establish sea otters in British Columbia at the Bunsby Islands in Kyoquot Sound on the west coast of Vancouver Island beginning in 1969 (Bigg & MacAskie 1978) which now appears to have succeeded (Denning 1984). The demise of the Queen Charlotte Islands sea otter population has led to a profound change in the marine nearshore environment due to the fact that kelp beds have declined from grazing pressure by abalone and sea urchin whose primary predator was once the sea otter (Denning 1984). That decline in kelp beds not only eliminates habitat for a number of other animal and plant species, but it reduces the chances for successful reestablishment of the sea otter in the Queen Charlotte Islands.

a) RESOURCE ANALYSIS

The analytical problems posed by the fact that the marine faunal populations are both more abundant and more dispersed than their terrestrial counterparts is no better illustrated than in the case of the marine microbiota. As the fundamental animals in the food chain, the microbiota have an importance quite disproportionate to their size and visibility.

So too does the appearance of zooplankton belie their value as food for fish in particular. Seasonal variation in zooplankton populations follows that of the phytoplankton.

Most of the more than 100 species of marine invertebrates known to inhabit the marine environment of the Queen Charlotte Islands are common in the South Moresby area. The fact that they are largely creatures of the sea floor and substrate makes it possible to identify discrete populations, though the nature of the marine environment is such that marine invertebrate inventory is both time consuming and expensive.

The marine fish population of the Queen Charlotte islands is at once diverse (with 315 species in 76 families) and widely distributed (with groundfish, anadromous species, pelagic species and inshore species occupying habitats from the salt water/fresh water interface and inland, to the deep ocean). Most stocks are highly mobile, moving in and out of the proposed marine park reserve frequently to make use of more than one type of habitat. The consequences of such mobility are that stocks are largely estimated on the basis of the catch in the sport and commercial fishery. Except in the case of anadromous species, numbers are impossible to identify, and even in the case of the salmonids, inventory is a costly process.

The solitary herpetile of the coastal waters of the Queen Charlotte Islands is the Pacific leatherback turtle. Four of the 14 known sightings in British Columbian waters have occurred in the Queen Charlotte Islands area.

The single most visible form of marine life to all visitors to South Moresby Island is the marine bird life. Of the 86 species of birds associated with marine habitat (Anon. 1983a), 50 of those are marine birds, and of those 50, 22 are sea or shore birds which nest in the area (Cowan 1989). One-third of the 1.5 million seabirds which breed annually in the Queen Charlotte Islands do so on South Moresby (Cowan 1989).

The species of marine mammals found in the area of the Queen Charlotte Islands are relatively few compared to their bird, fish and invertebrate counterparts. Nonetheless, by virtue of their physical size and relatively small populations they take on an importance comparable to or greater than that of some of the other classes of the animal kingdom.

- Management Concerns

While there is no concern that there may be a potential fishery for the marine microbiota, there is concern that their numbers can be drastically affected by pollution, both organic and otherwise. The oleoclastic bacteria are undocumented in the region, but they could be of benefit in the event of hydrocarbon pollution of the marine environment.

Though the production of zooplankton varies seasonally as does that of phytoplankton, the two standing crop figures may not correlate due to the fact that zooplankton can graze at a rate approaching that of phytoplanktonic production. A small euphasiid fishery has been operating in the region since 1975.

All of the marine invertebrates of the Queen Charlotte Islands have the potential to face commercial, native and sport harvesting. Such exploitation was traditionally based on oysters, clams, crabs and shrimps, but the industrial catch is expanding to include mussels, abalone, gedoucks, scallops, horse clams, sea urchins, squid, and octopuses amongst other invertebrates. Commercial extraction is coming to rely not only on wild stocks but on mariculture as well. The harvest of marine invertebrates impacts not only on the target species but on their predators and prey, both faunal and floral. As marine invertebrates tend to occupy more discrete environments than do pelagic fauna, the opportunity exists for managers to protect local populations within the proposed marine park reserve through the protection of habitat and the restriction of harvesting. The potential for catastrophic impact of offshore oil spills on marine invertebrates has recently been emphasized in the wake of the NESTUCCA and EXXON VALDEZ disasters on the Pacific Northwest coast.

As with the marine invertebrates, so too are all of the marine fishes of the Queen Charlotte Islands region subject to potential resource extraction by commercial, native and sport fishing interests. Particularly in the case of the salmonids, fishing is an important economic activity, the disposition of which is subject to political arbitration. The mobile nature of marine fish populations render them subject to influences both within and outside of the proposed national marine park reserve. Therefore, management of marine fish stocks can only be effective through a cooperative management effort.

There are no major rookeries for the Pacific leatherback turtle in North America. It breeds offshore of its rookeries and emerges on to land only to lay eggs. The animal is carnivorous and favours jellyfish as prey. It is hunted in the tropics for its oil and its eggs. As with all of the world's sea turtles, it is in need of a cooperative conservation effort. The species is considered endangered by many (Gregory & Campbell 1984).

The marine habitat of the Queen Charlotte Islands is important to 50 species of marine birds and 36 species of terrestrial birds. It is vital to the 22 species of sea and shore birds nesting there each year. They rely not only upon a constant food source but on a breeding refuge free from harrasment by man or introduced species. Predation by raccoon and the Alexandrian rat threaten nesting seabird colonies throughout the Queen Charlotte Islands (Summers & Rodway 1988). Eagles, peregrine falcons and marten rely upon seabirds as prey.

Several species of marine mammal are common enough in the study area to be of concern. The Pacific white-sided dolphin is common offshore. There are both resident and transient pods of killer whale in the area. Both the Dall's porpoise and the harbour porpoise are common year-round. Of the baleen whales, only the gray whale and the minke whale are common. Virtually the whole of the eastern Pacific population of gray whales transits the waters adjacent the Queen Charlotte Islands in the course of the year. The Steller sea lion rookery near Cape St. James (the only one in the Queen Charlotte Islands) is the largest on the west coast of North America. The northern fur seal is common offshore in migration, and the harbour seal is a common inshore resident. The river otter is a common inshore resident and the only marine carnivore at present in the area. Sea otter, once plentiful in the region, were hunted to extinction. Any effort to re-introduce the species must take into account that the kelp bed habitat in which the animal thrives has been vastly reduced due to grazing by abalone and sea urchin, two of the sea otter's principal prey .

- Status of Knowledge

Site-specific microbiological data for the northern British Columbia Continental shelf region is absent, though there is some knowledge of the cycles of production (Dilke et al. *1979; Perry* et al. *1981).*

The mechanisms of zooplanktonic production are documented (Barnes & Hughes 1988; Brodie et al. *1978; Dilke* et al. *1979; Fournier* et al. *1977; Gardner 1980, 1982a,b; Perry* et al. *1981; Parsons* et al. *1977) but what is known of distribution is not locally specific (Cameron 1957, LeBrasseur 1965, Parsons 1965, Perry 1989, Perry et al. 1983, Walters 1978).*

Knowledge of the habits of marine invertebrate species along the British Columbian coast is extensive, but knowledge of specific stocks tends to be confined to those species of interest to the sport and commercial fisheries. Bernard (1982) investigated the conservation of Dunginess crab, geoduck, razor clam and abalone in the Queen Charlotte Islands. Searing & English (1983) have recently described the invertebrates of South Moresby as they relate to a natural theme inventory. Two recent environmental evaluations, one by Chevron Canada Resources Ltd. (Anon. 1982) and one by Petro-Canada Inc. (Anon. 1983a) provide summaries of marine invertebrate information with an emphasis on the commercially important species.

The emphasis within the literature on species of sport and commercial interest carries over from the marine invertebrates to the marine fish as well. Several of the information sources are similar. Searing & English (1983) have described the fish of South Moresby as they relate to a natural theme inventory. Searing (1987) has also discussed fish habitat as it relates to the proposed national marine park reserve. Herring spawning grounds and the spawn on kelp fishery have been discussed by Hourston & Haegele (1980) and Shields et al. *(1985). Much of what is known of stocks relates to sport and commercial catch records. Two recent environmental evaluations, one by Chevron Canada Resources Ltd. (Anon. 1982) and one by Petro-Canada Inc. (Anon. 1983a) provide summaries of information on marine fish populations and habits with an emphasis on the commercially important species. Northcote* et al. *(1989) have produced the most current summary of the fisheries for the waters of the Queen Charlotte Islands.*

Little information is available on the Pacific leatherback turtle in British Columbian waters. Gregory & Campbell (1984) have provided the only summary of its habits and records to date.

Seabirds are one of the best-known natural resources of the Queen Charlotte Islands, and much of the information is current (Anon. 1983a; Anon. 1982; Bertram 1989; Campbell 1984; Campbell & Garrioch 1979; Cowan 1989; Godfrey 1986; Rodway et al. *1989, in prep.; Summers & Rodway 1988). The shorebirds are less well known, however, in terms of their distribution and abundance. Seabird-raccoon interactions are only beginning to be explored (Summers & Rodway 1988).*

Recent work on marine mammals by Cowan (1989), Baird & Stacey (1989) and Denning (1984) have provided a valuable update to the earlier comprehensive works of Pike & MacAskie (1969), and Nishiwaki (1967). Much of the work on the Cetacea is fairly current (Allen 1980; Baird & Stacey in press; Bigg et al. *1987, Darling 1977; Murison* et al. *1974; Reeves & Mitchell 1988). The pinnipeds are covered well by few authors (Bigg 1969, 1988a, 1988b; Leatherwood & Reeves 1978). The information on marine carnivores (otters) is sparse (Bigg & MacAskie 1978; Edie 1973; Taylor & Gough 1977).*

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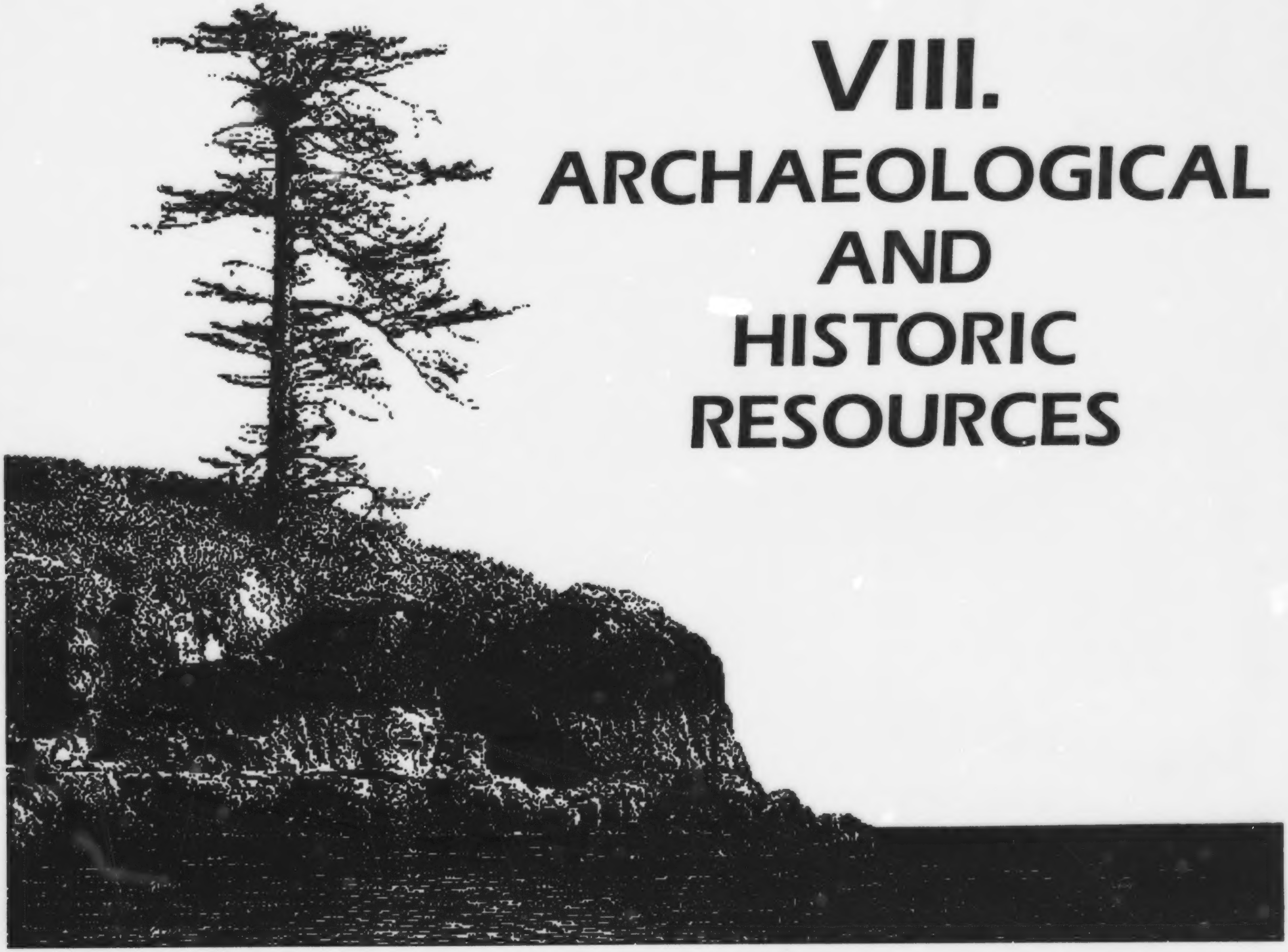
VIII.
ARCHAEOLOGICAL AND HISTORIC RESOURCES



ARCHAEOLOGICAL AND HISTORICAL RESOURCES

General Overview

To describe what is known about the long history of the Haida (the "People"), is to describe the original human face of the Queen Charlotte Islands; the two are synonymous. The Haida were a maritime people whose villages, isolated though they were, occupied certain vantage points along the much indented coastline of the Islands from which these intrepid voyagers exercised their dependence on and mastery over the sea. Yet their history records but the last chapter, a few thousand years at best, of the much larger drama better referred to as the *peopling* of North America.

It is now believed that in a much broader historical context, the first of the original human inhabitants of North America brought a Late Mousteroid culture with some Upper Paleolithic elements from Siberia to Alaska and thence into the American Southwest, at about the height of the Wisconsinan Glaciation. The same glaciation had spawned the ice sheets that somewhat later are believed to have blocked all corridors of travel southward. These earliest of inhabitants survived the long glacial encroachment by remaining south of the ice lobes, where they evolved into a variety of hunting and gathering groups (Borden 1969) that will not be considered herein any further.

Recent data indicate that people of a Monolithic culture (Early Boreal Cultural Tradition) spread from Siberia across Beringia into the unglaciated interior of Alaska as the Pleistocene Epoch began to wane, about 10,000 years ago. They are believed to have migrated from there through a newly deglaciated corridor between the Rocky Mountains and the Coast Mountains to reach what is now the the Pacific Northwest of the United States of America (Borden 1969). This has been the only major detectable movement in early postglacial times of a culture and its people streaming southward into the western parts of North America.

So, while early man roamed the unglaciated plains of the American interior south of the ice front, the area now known as British Columbia was covered with vast ice sheets of the last Continental glaciation. Carlson (1970) postulated that those ice sheets had melted back far enough by about 8,500 B.C., to allow a slow northwestward movement of human cultural groups (Proto-Western Cultural Tradition) from south of the ice front into the newly deglaciated western and coastal areas of the State of Washington and the province of British Columbia.

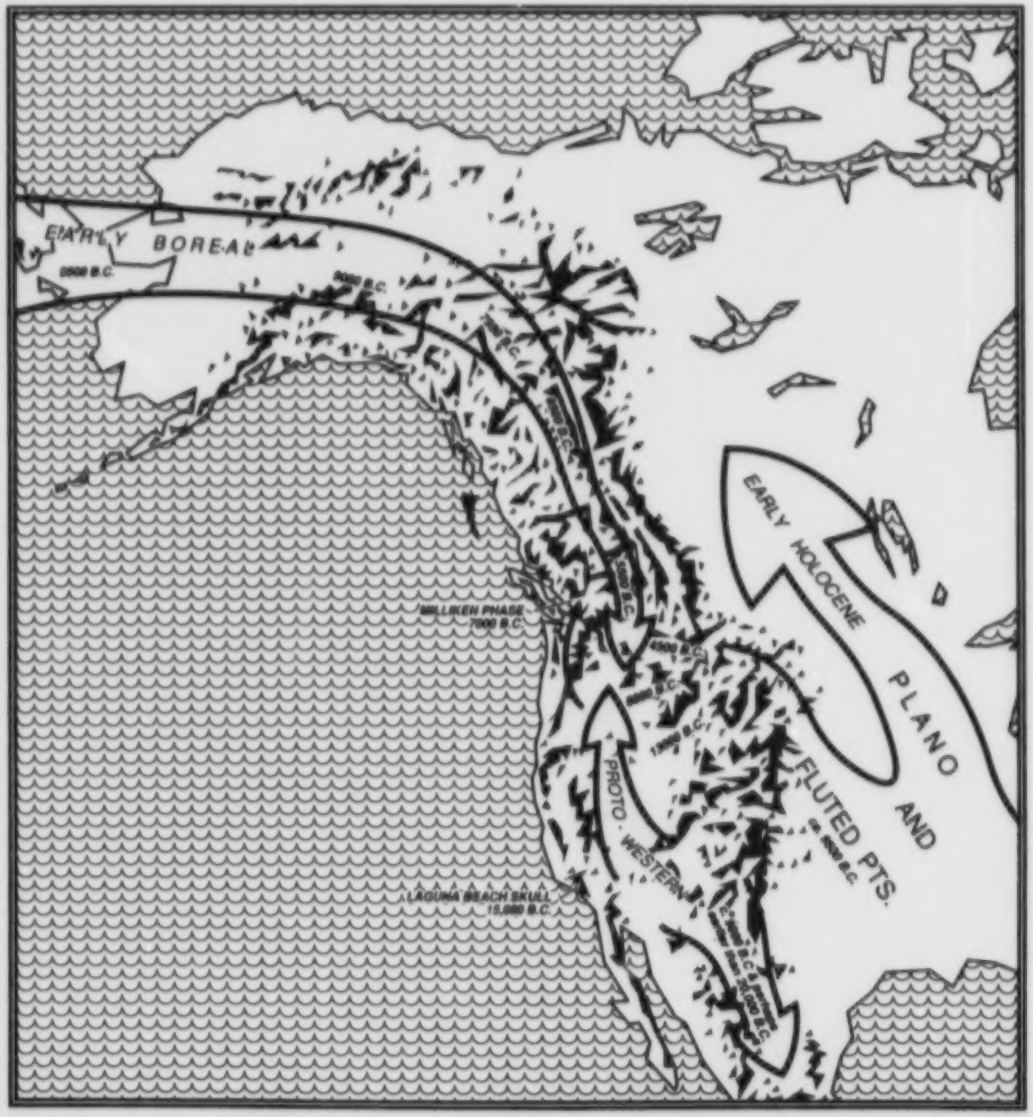
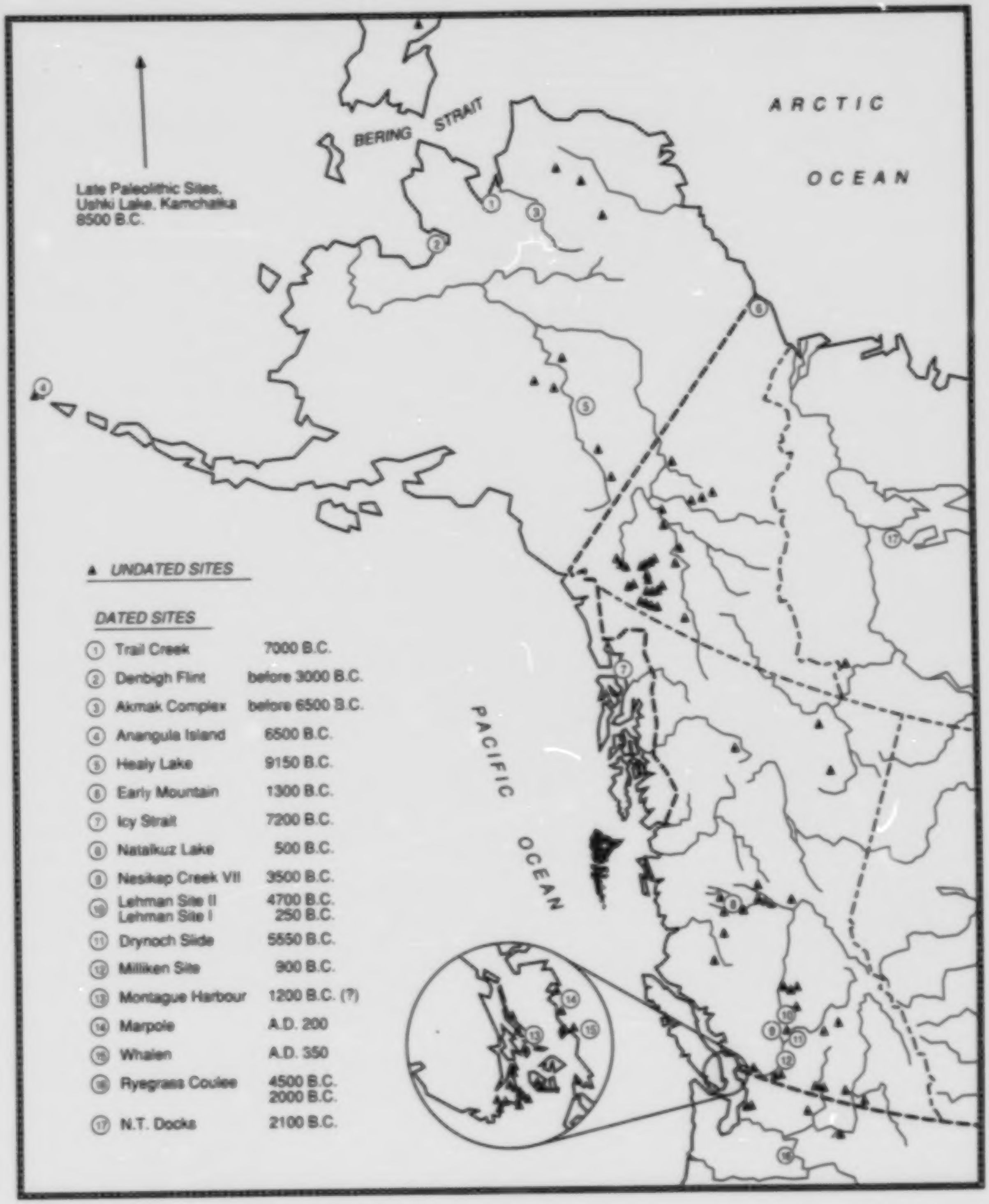

EARLY BOREAL
EARLY HOLOCENE
PLANO AND FLUTED PTS.
PROTO-WESTERN
MILLIKEN PHASE
5000 B.C.
LAGUNA BEACH SKULL
15,000 B.C.

Figure 157. Schematic presentation of major population movements during the Terminal Pleistocene and Early Holocene, as inferred from the distribution in space and time of the manifestations of important early cultural traditions (after Borden 1969).



BERING STRAIT
ARCTIC OCEAN
PACIFIC OCEAN
Late Paleolithic Sites, Ushki Lake, Kamchatka 8500 B.C.
▲ UNDATED SITES
DATED SITES
① Trail Creek 7000 B.C.
② Denbigh Flint before 3000 B.C.
③ Akmak Complex before 6500 B.C.
④ Anangula Island 6500 B.C.
⑤ Healy Lake 9150 B.C.
⑥ Early Mountain 1300 B.C.
⑦ Icy Strait 7200 B.C.
⑧ Natalkuz Lake 500 B.C.
⑨ Nesikep Creek VII 3500 B.C.
⑩ Lehman Site II 4700 B.C.
Lehman Site I 250 B.C.
⑪ Drynoch Slide 5550 B.C.
⑫ Milliken Site 900 B.C.
⑬ Montague Harbour 1200 B.C. (?)
⑭ Marpole A.D. 200
⑮ Whalen A.D. 350
⑯ Ryegrass Coulee 4500 B.C.
2000 B.C.
⑰ N.T. Docks 2100 B.C.

Figure 158. Microblade sites in Alaska and British Columbia providing evidence of major population movements from the early Holocene, A.D. 350 (after Borden 1969).

So far, that movement has been traced by its pebble tool assemblage to what is referred to by Borden (1969), as the Millikan Phase, circa 7,000 - 6,200 B.C., situated in the lower Fraser Canyon. It is now generally surmised that as the major Pacific river valleys along the west coast of British Columbia became settled by early native people, fishing societies began to develop that adapted themselves to the exploitation of the Pacific Ocean and the exploration of near-shore islands (Owen *et al.* 1967), thereby diverging significantly from the previous and largely Continental "hunting - gathering" cultural patterns. Borden (1969), employed the research results of a sizable number of archaeological scientists to compile a comparative cultural chronology of British Columbia for the past 10,000 years that appears to firmly support the cultural diversification alluded to above.

Two types of assumptions which adhere only partly to the generalized background just presented, have been suggested in the literature in the attempt to explain where the progenitors of the modern Haida might have come from and how they got to establish their culture on the Queen Charlotte Islands. Smith (1982) suggests that there is support for the hypothesis that the Haida and Tlingit might at one time have been a single cultural group that lived near the lower Skeena River. When the Tsimshian invaded that area, the Tlingit were forced to move northward, at which point the Haida chose to separate themselves from the "parent stock" and instead migrate to the Queen Charlotte Islands, where they are said to have first settled in the vicinity of Skincuttle Inlet. Fladmark (1989) on the other hand, has repeatedly suggested that because it is now known that the northeastern portion of Graham Island has been unglaciated and vegetated for the past 16,000 years, other areas and islands along the North Pacific coast may also have been ice-free and thus may have served as refugia. He believed it to be conceivable, therefore, that a maritime-adapted early people might have been able to migrate from northern Alaska southward along the mainland coastline, with the Queen Charlotte Islands being one of their natural stops. Because of late glacial and postglacial sea-level changes, their habitation and activity sites would now lie beneath the waters of Dixon Entrance and Hecate Strait. Furthermore, inferences made by Hobler (1978) make it sound reasonable that the assemblage of crude stone tools found in the intertidal zone of South Moresby Island does pre-date 10,000 years before the present. If found to be correct, that time line could provide credence to Fladmark's suggestions.

Leaving conjecture, what has been established is (Fladmark 1989) that the oldest formally defined and radiocarbon date-supported cultural complex of the Islands flourished from at least 8,000 to 5,500 years before the present, and is now referred to as the *Moresby Tradition* . This tradition was distinguished by its well-developed microblade industry. The *Graham Tradition* supplanted the former tradition. It flourished between about 5,500 and 4,500 years before the present, and marked the end of the microblade industry and the introduction of new tools, as well as giving rise to the occurrence of the first shell-middens. A transitional cultural complex appears to have bridged the two cultural traditions for a while. Barbed harpoon heads, bone fish-hooks, and needles had made their appearance by 3,000 years B.P., and even though the archaeological record is said to be poorly represented around and after 2,000 years B.P., splitting adzes and hafted mauls had made their appearance by this time, as part of a "heavy-duty woodworking tool kit (Fladmark 1989). As can be seen from the preceding and much compressed representation of the relatively meager archaeological record, at the time their encounter with European culture took place around 1774, the island culture of the Haida had evolved through millenia of change, accretion, and innovation in response to new patterns introduced from contacts with the mainland.

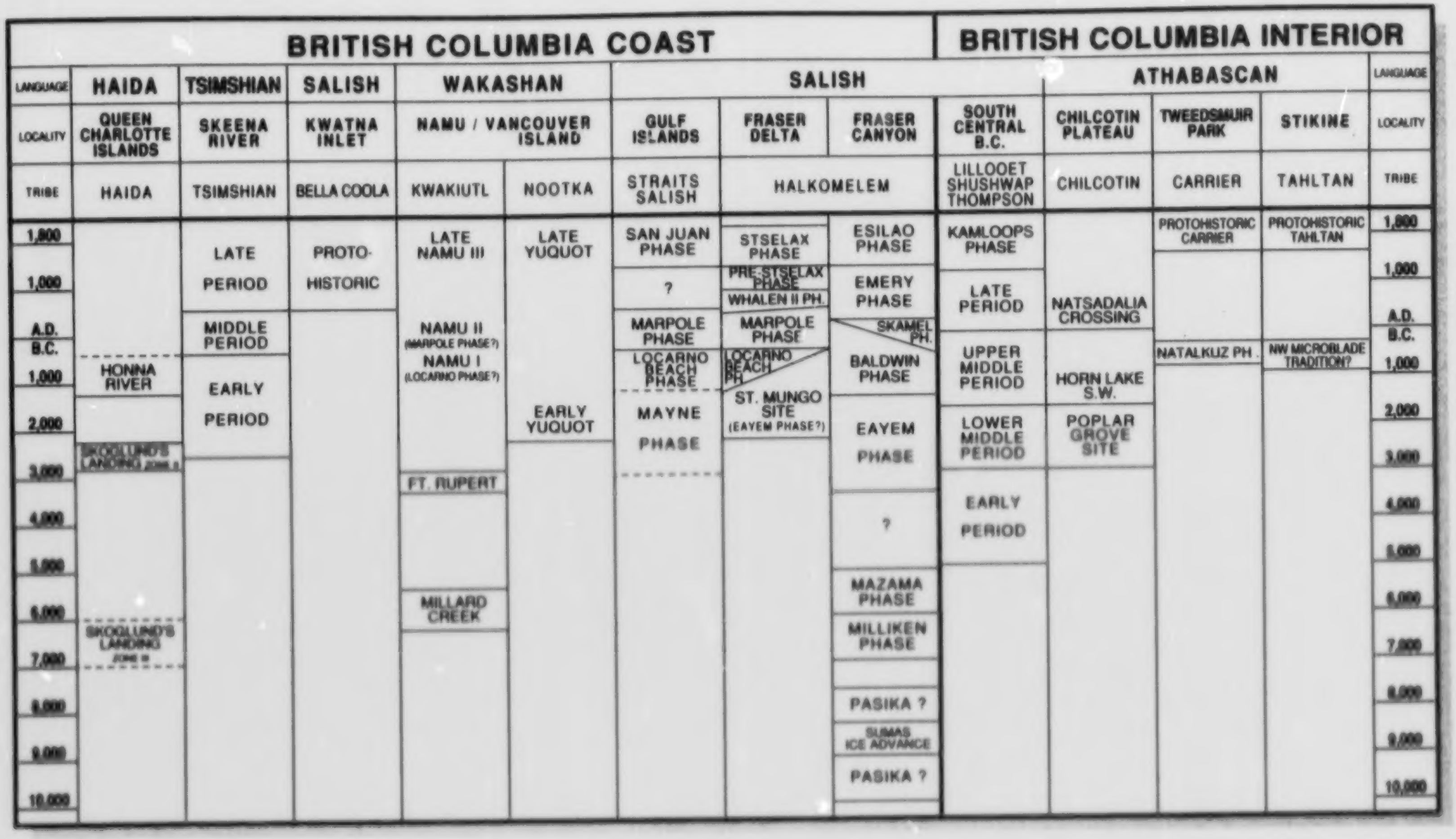

BRITISH COLUMBIA COAST
BRITISH COLUMBIA INTERIOR
LANGUAGE
HAIDA
TSIMSHIAN
SALISH
WAKASHAN
SALISH
ATHABASCAN
LOCALITY
QUEEN CHARLOTTE ISLANDS
SKEENA RIVER
KWATNA INLET
NAMU / VANCOUVER ISLAND
GULF ISLANDS
FRASER DELTA
FRASER CANYON
SOUTH CENTRAL B.C.
CHILCOTIN PLATEAU
TWEEDSMUIR PARK
STIKINE
TRIBE
HAIDA
TSIMSHIAN
BELLA COOLA
KWAKIUTL
NOOTKA
STRAITS SALISH
HALKOMELEM
LILLOOET SHUSHWAP THOMPSON
CHILCOTIN
CARRIER
TAHLTAN
1,800
1,000
A.D.
B.C.
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
HONNA RIVER
SKOGLUND'S LANDING ZONE II
SKOGLUND'S LANDING ZONE I
LATE PERIOD
MIDDLE PERIOD
EARLY PERIOD
PROTO-HISTORIC
LATE NAMU III
NAMU II (MARPOLE PHASE?)
NAMU I (LOCARNO PHASE?)
FT. RUPERT
MILLARD CREEK
LATE YUQUOT
EARLY YUQUOT
SAN JUAN PHASE
?
MARPOLE PHASE
LOCARNO BEACH PHASE
MAYNE PHASE
STSELAX PHASE
PRE-STSELAX PHASE
WHALEN II PH.
MARPOLE PHASE
LOCARNO BEACH PH.
ST. MUNGO SITE (EAYEM PHASE?)
ESILAO PHASE
EMERY PHASE
SKAMEL PH.
BALDWIN PHASE
EAYEM PHASE
?
MAZAMA PHASE
MILLIKEN PHASE
PASIKA ?
SUMAS ICE ADVANCE
PASIKA ?
KAMLOOPS PHASE
LATE PERIOD
UPPER MIDDLE PERIOD
LOWER MIDDLE PERIOD
EARLY PERIOD
NATSADALIA CROSSING
HORN LAKE S.W.
POPLAR GROVE SITE
PROTOHISTORIC CARRIER
NATALKUZ PH.
PROTOHISTORIC TAHLTAN
NW MICROBLADE TRADITION?

Figure 159. Cultural chronology in British Columbia (after Carlson 1970).

A. TERRESTRIAL ARCHAEOLOGICAL RESOURCES

In his treatise of the archaeology of British Columbia, Carlson (1970) compiled a listing of past archaeological activities within the province, culminating with Knut Fladmark's work on the Queen Charlotte Islands in 1969. Carlson made the important point that such archaeological investigations occurred primarily during two major activity periods; the first, around the turn of the century; the second, beginning just prior to 1950 and continuing to the present. The intervening period was apparently marked by sporadic activities only. Fladmark (1989) subsequently compiled what is perhaps the most up-to-date chronological listing of the history of archaeological investigations so far carried out on the Islands which is presented in a capsulated format as follows:

G. Dawson, 1878. Provided the first archaeological observations made during his survey of the Queen Charlotte Islands. He noted aboriginal shell middens and raised beaches in the Naden River area on Graham Island.

A. Mackenzie, 1890's. Serving as a Hudson's Bay Trader at Masset, Mackenzie obtained a collection of Haida ethnographic artifacts which he eventually donated to the Geological Survey of Canada Museum in Ottawa.

H.I. Smith, 1919. As a member of the National Museum of Canada, he conducted limited test excavations at the large prehistoric village site of Old Yakan on the north coast of Graham Island, where he made a small collection of stone and bone artifacts.

W. Duff & M. Kew, 1956-1957. These members of the British Columbia Provincial Museum conducted the first modern archaeological investigations as part of a project to salvage totem poles from the abandoned Haida village site of Ninstints on Anthony Island.

G. MacDonald, 1966-1967 The National Museum of Man began its North Coast Prehistory Project in 1966 at the harbour of Prince Rupert as well as commencing to document and map prehistoric and historic sites on the Queen Charlotte Islands. The study of the Islands continued into 1967 with excavations at the prehistoric Honna River shell-midden site near Queen Charlotte City. Other summer crews recorded and salvaged the Gust Island burial site in the Skidegate Inlet during the same year.

K. R. Fladmark, 1969-1970. Directed small-scale excavations for the Simon Fraser University at Skoglund's Landing near Masset, Richardson's Ranch and Lawn Point sites on the east coast of Graham Island, and tested the Blue Jackets Creek shell-midden near Masset and "Kasta" south of Sandspit.

N. Gessler & T. Gessler, 1974. Reported on the petroglyphs of the Queen Charlotte Islands.

P. Sutherland (Severs), 1972-1974. This member of the University of Alberta conducted excavations at Blue Jackets Creek near Masset and other sites.

N. Gessler, 1972-1975. Conducted an intensive reconnaissance of the Skidegate Inlet, where he located 75 sites. He followed that work with several excavations at the historic Kiusta village site.

P. Hobler, 1974-1975. This member of the Simon Fraser University conducted the first systematic archaeological survey of Moresby Island, with special focus on South Moresby Island and the UNESCO World Heritage Site on Anthony Island.

N. Gessler & L. Watney, 1976. Conducted an archaeological reconnaissance from Rennel Sound to Tian Head on Graham Island and presented their findings in an unpublished report to the provincial Heritage Conservation Branch in Victoria.

N. Gessler & M. Morris, 1979. Prepared an unpublished report on the Frank's Cave for the provincial Heritage Conservation Branch in Victoria.

D. Abbot & S. Acheson, early 1980's.
Confirmed the depth and age of the deposits at Ninstints, and continued the intensive site survey of Kunghit Island.

The two major periods of research referred to above have opened the door to understanding many of the important cultural aspects of the prehistory of the Haida, even though the time and method of the arrival of the Haida within the region remains uncertain.

The traditional Haida society can only be appreciated by outsiders in the context of how they saw themselves and their creation in mythology. Swanton (1905), Smith (1982), and MacDonald (1983) noted and described that members of the "Raven" moiety lay claim to an ancient association with the Queen Charlotte Islands to the farthest reaches of their distant past. Their ancestors are said to have emerged from a primaeval flood on one of the reefs in Skinkuttle Inlet. The "Eagle" moiety by contrast appears to be of a more recent innovation with relationships to the mainland, and whose ancient supernatural beings are mostly considered to be of a "raven" moiety origin (Fladmark 1989). For those readers who are not familiar with the myth of the origin of Haida society, Smith (1982) provided a generalized account of the story of their creation, incorporating only the common parts of other variations of the myth, that is well worth repeating here:

The first period of history is characterized as being an era in which only Supernatural Beings existed. There was a wide expanse of sea containing a single reef which these Beings inhabited. Above was an equally wide expanse of sky. The *Raven*, an important Being in Haida history, flew above the reef looking for a place to land. Due to the crowded condition of the reef this was impossible, and so he flew off to visit the sky kingdoms. There are many tales about what happened to the Raven during this visit, but they have no importance to this discussion. Eventually he returned to the sea and created the Queen Charlotte Islands along with other natural phenomena. The Supernatural Beings then took up residence under various mountains, lakes and islands, and have remained in these lower regions ever since. A great flood then occurred and marks the end of the first cycle of Haida mythology.

After the water subsided, a reef arose with *Foam Woman* sitting on it. The reef was called Xaigi and was supposed to have been situated somewhere in Skinkuttle Bay which is located on the southeastern shore of Moresby Island. Foam Woman appeared to be supreme over the other Supernatural Beings and was recognized by the Haida as being the grandmother of all the Raven families on the Islands. The Raven's original villages, or in other words the earliest villages recalled by the Haida, were located at Xaiga, Atana, and Rose Spit groups still considered themselves descendants of Foam Woman.

***Djilaqons* was one of the Supernatural Beings who was considered to be inferior to Foam Woman. This former Being was recognized as the ancestor of most of the *Eagle* lineages whose place of origin was also in the vicinity of Xaiga. These Eagles were divided into two families: Nin-stints and Property-Making-A-Noise. There was also a northern group of Eagles who had their traditional origin at Rose Spit and did not consider themselves to be descendants of Djilaqons.**

From these points of origin the Haida spread out over the entire Queen Charlotte Islands and parts of Alaska.

Swanton (1909) and later MacDonald (1983), provided detailed descriptions of movements of the Haida, including those of the descendants of *Labret-Woman* (a branch of the Eagles that do not trace their origins back to Djilaqons).

Well prior to their encounter with European culture, the Haida had developed a complex social structure and organization that was rich in artistic ability, while giving expression to their feelings for both the natural and supernatural worlds. They had arranged their society into two exogamous matrilineal groups (Smith 1982), or moieties, which were referred to as "Ravens" and "Eagles", and whose primary function it was to regulate marriages between the groups (Swanton 1909; MacDonald 1983). The life of individu-

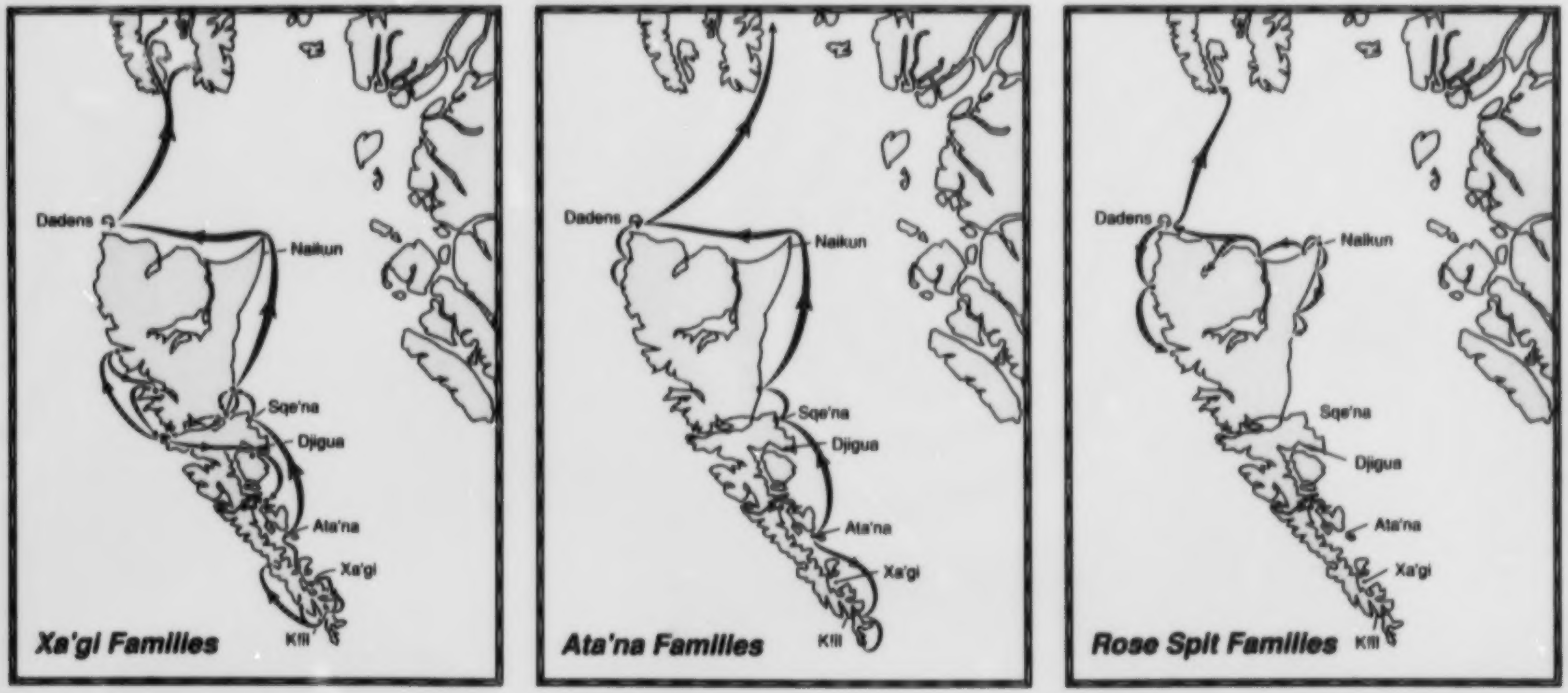

Dadens
Naikun
Sqe'na
Djigua
Ata'na
Xa'gi
K!ii
Xa'gi Families
Dadens
Naikun
Sqe'na
Djigua
Ata'na
Xa'gi
K!ii
Ata'na Families
Dadens
Naikun
Sqe'na
Djigua
Ata'na
Xa'gi
K!ii
Rose Spit Families

Figure 160. Early migrations of Haida families (after MacDonald 1983).

als were regulated by avunculate, sororate, levirate, or cross-cousin marriage, and there were many taboos to meet, including those that affected pregnancy and birth (Smith 1982).

Both groups were further subdivided into lineages that normally took the name of the village they originally inhabited. Lineages were further made up of individual households, the wealthiest or most prestigious of which provided positions such as that of house chief or even lineage chief. The Raven lineages numbered twenty-two; that of the Eagles twenty-three. House chiefs ruled their household members and were part of the

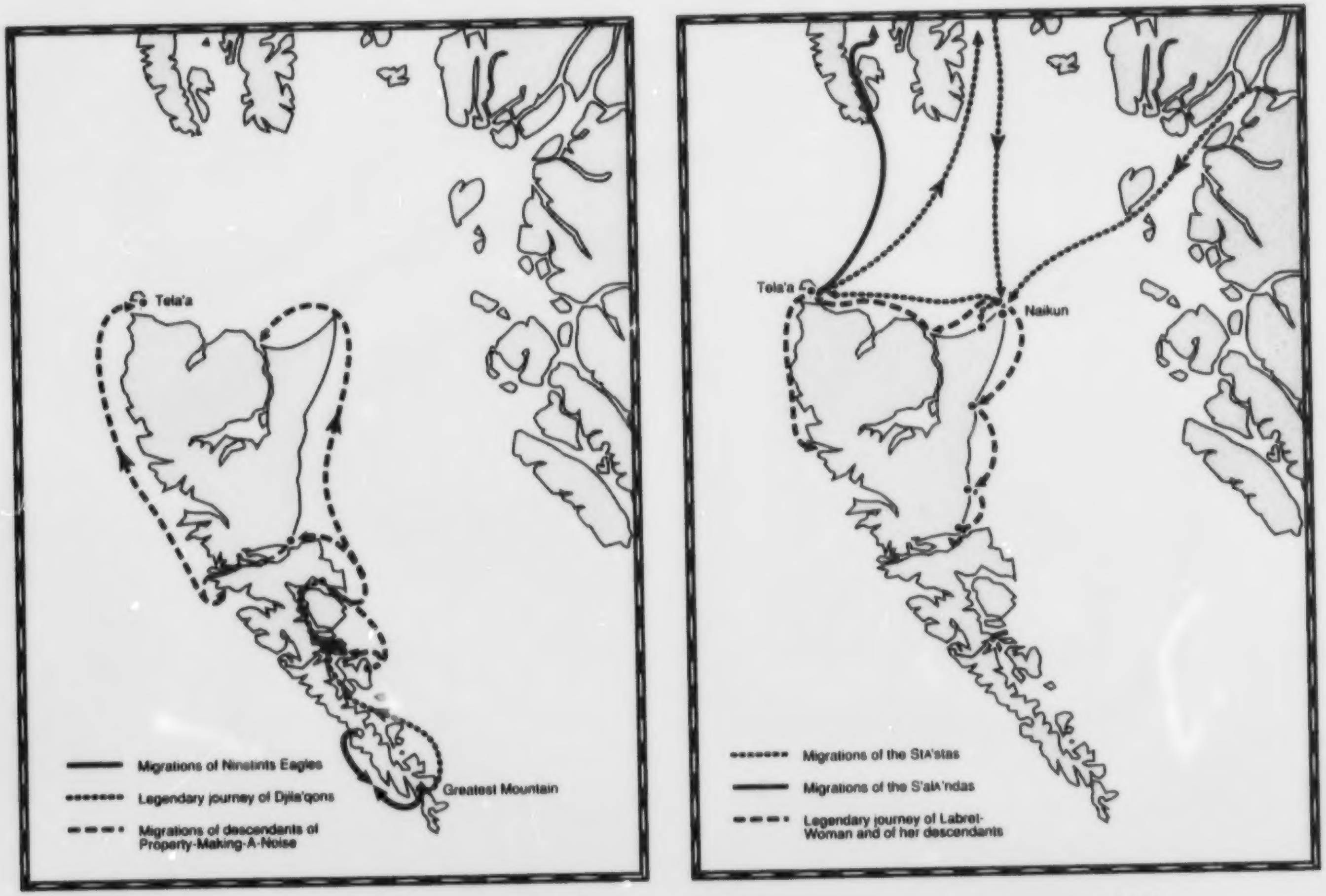

Tela'a
Greatest Mountain
Migrations of Ninstints Eagles
Legendary journey of Djila'qons
Migrations of descendants of Property-Making-A-Noise
Tela'a
Naikun
Migrations of the StA'stas
Migrations of the S'alA'ndas
Legendary journey of Labret-Woman and of her descendants

Figure 161. Legendary and early migrations of Haida families (after MacDonald 1983).

lineage chief's council. Both positions were inherited through the matrilineal line. A chief was first succeeded by his brother, then by a nephew, or a sister as the last resort. Where no heir to a village chief existed, house chiefs appointed a successor (Smith 1982). Three classes of people were recognized in Haida society; *i.e.*, nobles, commoners, and slaves. The latter status was inherited, while the former two could neither be inherited nor earned by an individual, but depended instead on whether his parents had held a "potlatch" either before or after his birth. If they had not, the best status an individual could attain was that of commoner (Smith 1982).

No political organization beyond the village level was practiced. Each lineage, and sometimes whole villages, laid exclusive claim to certain salmon streams, shore fronts, and berry patches. Trespassers had to obtain special permission to cross or use any of these areas, or face the threat of war. Some villages would unite to practice warfare on other villages or mainland tribes, but there is no record of all villages joining to fight a common threat (Smith 1989).

Focusing specifically on the group of Haida that occupied the South Moresby / Gwaii Haanas National Park Reserve prior to the times of European contact, MacDonald (1987) provided a description and spatial distribution of the various villages, the families and chiefs comprising the *Kunghit Haida*

KUNGHIT HAIDA

No:	Village:	Family:	Chief:
1.	"*Sqai* "	Those Born at Songs of Victory Town	"Master of the Fire"
2.	"*Xe-uda'o* " (= Village that always fishes towards the south)	Those Born at Songs of Victory Town	"Raven"
3.	"*Si'ndas Kun* " (= Village on a point which is always smelling)	Those Born at Songs of Victory Town	(not recorded)
4.	"*Lagi* "	Those Born at Songs of Victory Town	(not recorded)
5.	"*Sga'ngwa-i* " (= Red Cod Island Town)	Ninstints: Those born up the Inlet	"He who is two"
6.	"*Q'adadja'ns* " (= ref. to a person who is annoyed with someone else and talks behind their back)	Striped Town People	"Juicy Grass"
7.	"*Tcu'uga* " (= to go for cedar village)	Those Born at Songs of Victory Town & Those Born in the Southern Part of the Islands	"Thunderbird"
8.	"*Lgada'n* " (= ref. to someone who tries to surpass another, and will suffer for it)	Powerless Town People	(not recorded)

KUNGHIT HAIDA (continued)

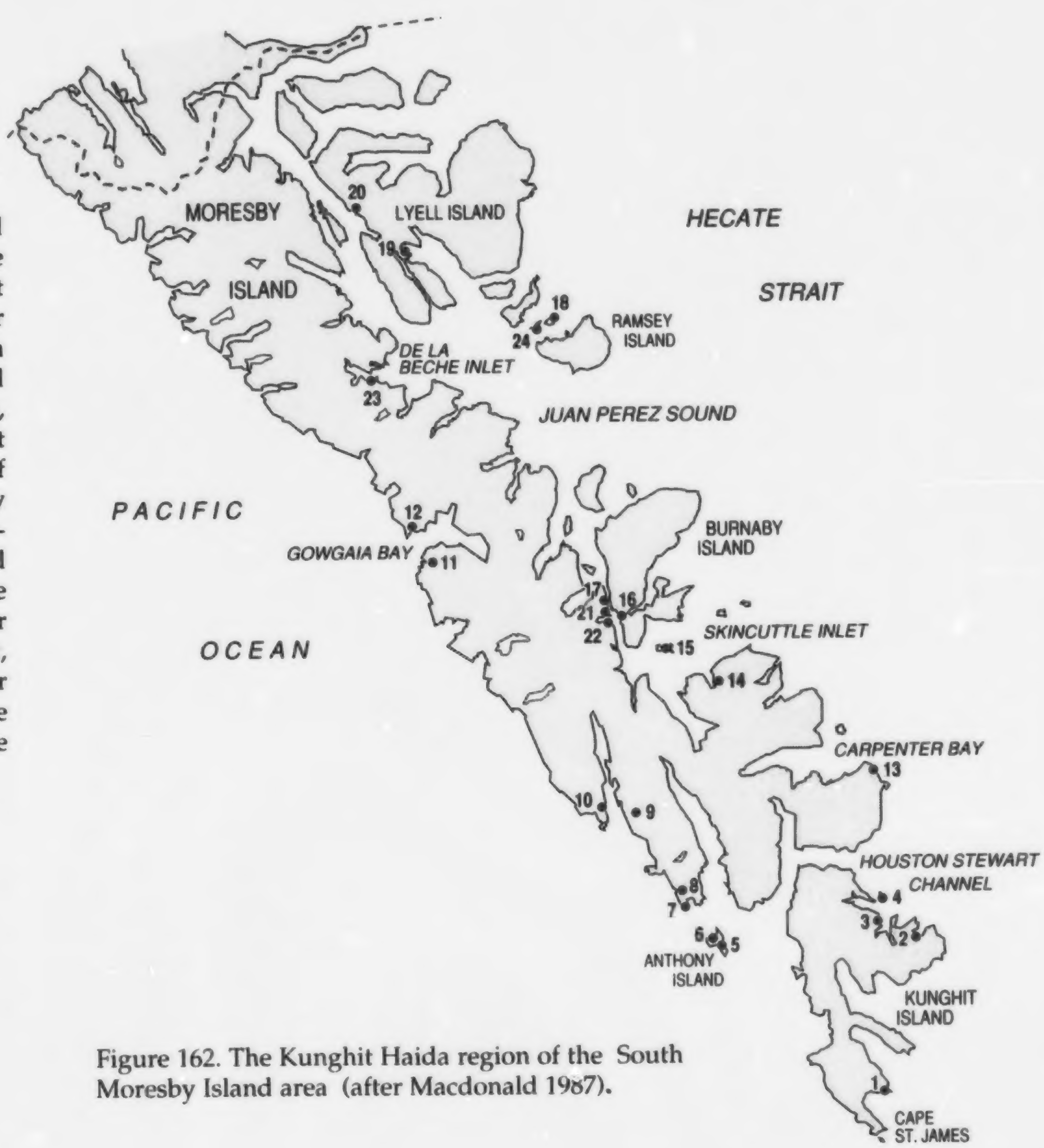
No:	Village:	Family:	Chief:
9.	*"Sl'i'ndagwa-i "* (= the Village deep in the inlet)	Striped Town People	"Hawk Feathers"
10.	*"Na'gas "*	Striped Town People	"Dead Fish drift ashore by the waves"
11.	*"Tcuq'e-u "* (= mouth of the Tide Village)	Those Born up the Inlet	"One without entrails"
12.	*"Sqi'lgi "* (= poss. "town where there are plenty of scoter ducks")	Those Born up the Inlet	"He who is two"
13.	*"Qai'dju "* (= Songs of Victory Town)	Sand Town People	"Kia'nskina-i"
14.	*"Ga'idi "* (= smelt village)	Sand Town People	"Kia'nskina-i"
15.	*"Xa'gi "*	Striped Town People	"Wada" (a type of clam)
16.	*"La'na da'gana "* (= badtalk village)	Those Born up the Inlet	"Gitkun"
17.	*"Q'et "* (= Narrow Strait Village)	Narrow Strait Town People	"Making a copper sound by lying upon it"
18.	*"Ata'na "*	Sand Town People	"Kia'nskina-i"

KUNGHIT HAIDA (continued)

No:	Village:	Family:	Chief:
19.	*"Ga-isiga's q'eit "* (= strait town where no waves come ashore)	Striped Town People	"Raven's Bones"
20.	*"Xo'tdjixoa's "* (= hair seal low tide town)	Striped Town People	"Gi'tiqo'na-i"
21.	*"Qai'djudal "*	Slaves	"Always ready for anything"
22.	*"La'na xa'wa "*	(not recorded)	(not recorded)
23.	*"Gado "*	(not recorded)	(not recorded)
24.	*"Gaiega'n kun "*	(not recorded)	(not recorded)

Note: For site locations of the village numbers, refer to Figure 162.

MacDonald (1983) stated that people had occupied the Queen Charlotte Islands for the past 10,000 years. Just prior to their contact with European culture, the people we refer to as the "Haida", were represented by a total population that may never have reached more than 6,000 individuals on the Islands, and possibly another 3,000 individuals that had moved to and lived on the Prince of Wales Archipelago of southeast Alaska. They conversed in four dialects; *i.e.*, Kunghit, Skidegate, Masset, and Kaigani, and generally lived in several dozen coastal villages. They were and are particularly well known for their expressive architecture and highly artistic, monumental totem poles that fronted their houses, as well as argillite carvings that have earned their craftsmen respect all over the world.


MORESBY
ISLAND
LYELL ISLAND
HECATE
STRAIT
RAMSEY
ISLAND
DE LA
BECHE INLET
JUAN PEREZ SOUND
PACIFIC
OCEAN
GOWGAIA BAY
BURNABY
ISLAND
SKINCUTTLE INLET
CARPENTER BAY
HOUSTON STEWART
CHANNEL
ANTHONY
ISLAND
KUNGHIT
ISLAND
CAPE
ST. JAMES
20
19
18
24
23
12
11
17
16
21
22
15
14
13
10
9
8
7
6
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4
3
2
1

Figure 162. The Kunghit Haida region of the South Moresby Island area (after Macdonald 1987).

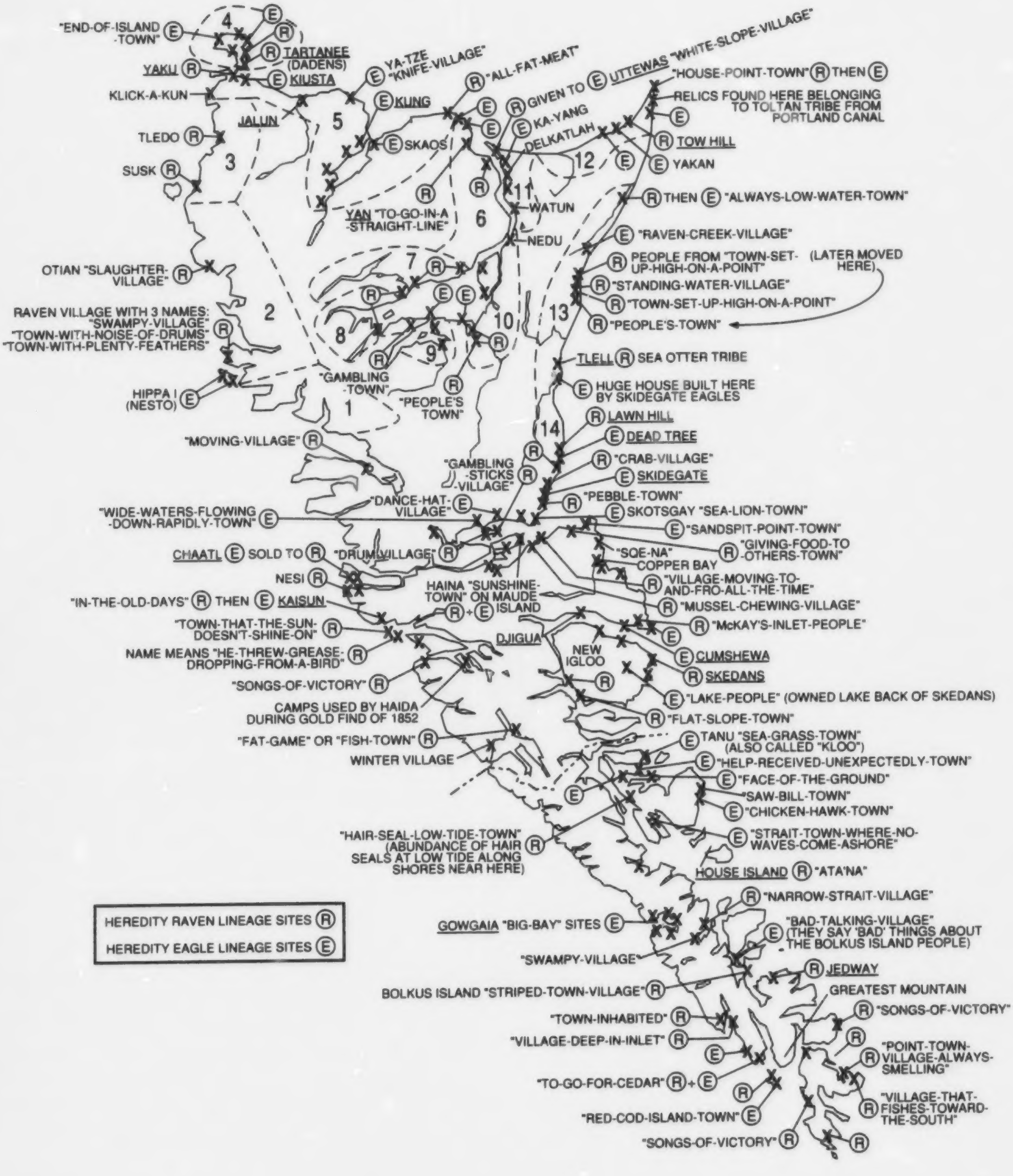

"END-OF-ISLAND -TOWN" Ⓔ
4
Ⓔ
Ⓡ
Ⓡ TARTANEE (DADENS)
YAKU Ⓡ
Ⓔ KIUSTA
KLICK-A-KUN
JALUN
Ⓔ YA-TZE "KNIFE-VILLAGE"
Ⓔ KUNG
5
Ⓔ SKAOS
TLEDO Ⓡ
3
SUSK Ⓡ
Ⓡ "ALL-FAT-MEAT"
Ⓔ
Ⓔ
Ⓡ GIVEN TO Ⓔ UTTEWAS "WHITE-SLOPE-VILLAGE"
Ⓔ KA-YANG
DELKATLAH
"HOUSE-POINT-TOWN" Ⓡ THEN Ⓔ
RELICS FOUND HERE BELONGING TO TOLTAN TRIBE FROM PORTLAND CANAL
Ⓔ
Ⓡ TOW HILL
Ⓔ YAKAN
12
Ⓔ
Ⓡ
Ⓡ
11
Ⓡ THEN Ⓔ "ALWAYS-LOW-WATER-TOWN"
WATUN
YAN "TO-GO-IN-A -STRAIGHT-LINE"
6
NEDU
Ⓔ "RAVEN-CREEK-VILLAGE"
OTIAN "SLAUGHTER-VILLAGE" Ⓡ
7
Ⓡ
Ⓡ PEOPLE FROM "TOWN-SET-UP-HIGH-ON-A-POINT"
(LATER MOVED HERE)
Ⓡ "STANDING-WATER-VILLAGE"
Ⓡ "TOWN-SET-UP-HIGH-ON-A-POINT"
Ⓡ "PEOPLE'S-TOWN"
13
Ⓡ
Ⓔ
Ⓔ
RAVEN VILLAGE WITH 3 NAMES: "SWAMPY-VILLAGE" "TOWN-WITH-NOISE-OF-DRUMS" "TOWN-WITH-PLENTY-FEATHERS" Ⓡ
2
8
Ⓡ
9
10
Ⓡ
Ⓡ
"GAMBLING -TOWN"
1
HIPPA I (NESTO) Ⓔ
Ⓡ "PEOPLE'S TOWN"
TLELL Ⓡ SEA OTTER TRIBE
Ⓔ HUGE HOUSE BUILT HERE BY SKIDEGATE EAGLES
14
Ⓡ LAWN HILL
Ⓔ DEAD TREE
"MOVING-VILLAGE" Ⓡ
Ⓡ
Ⓡ "CRAB-VILLAGE"
"GAMBLING -STICKS -VILLAGE" Ⓡ
Ⓔ SKIDEGATE
Ⓡ "PEBBLE-TOWN"
"DANCE-HAT-VILLAGE" Ⓔ
Ⓔ SKOTSGAY "SEA-LION-TOWN"
"WIDE-WATERS-FLOWING -DOWN-RAPIDLY-TOWN" Ⓔ
Ⓔ "SANDSPIT-POINT-TOWN"
CHAATL Ⓔ SOLD TO Ⓡ
"DRUM-VILLAGE" Ⓡ
"SQE-NA" COPPER BAY
Ⓡ "GIVING-FOOD-TO -OTHERS-TOWN"
NESI Ⓡ
HAINA "SUNSHINE-TOWN" ON MAUDE ISLAND
Ⓡ "VILLAGE-MOVING-TO-AND-FRO-ALL-THE-TIME"
"IN-THE-OLD-DAYS" Ⓡ THEN Ⓔ KAISUN
Ⓡ + Ⓔ
Ⓡ "MUSSEL-CHEWING-VILLAGE"
"TOWN-THAT-THE-SUN-DOESN'T-SHINE-ON" Ⓡ
Ⓡ "McKAY'S-INLET-PEOPLE"
Ⓔ
DJIGUA
NEW IGLOO
Ⓔ CUMSHEWA
NAME MEANS "HE-THREW-GREASE-DROPPING-FROM-A-BIRD" Ⓡ
Ⓡ SKEDANS
"SONGS-OF-VICTORY" Ⓡ
Ⓡ
Ⓔ "LAKE-PEOPLE" (OWNED LAKE BACK OF SKEDANS)
CAMPS USED BY HAIDA DURING GOLD FIND OF 1852
Ⓡ "FLAT-SLOPE-TOWN"
"FAT-GAME" OR "FISH-TOWN" Ⓡ
Ⓔ TANU "SEA-GRASS-TOWN" (ALSO CALLED "KLOO")
WINTER VILLAGE
Ⓔ "HELP-RECEIVED-UNEXPECTEDLY-TOWN"
Ⓔ "FACE-OF-THE-GROUND"
Ⓔ
"SAW-BILL-TOWN"
Ⓔ "CHICKEN-HAWK-TOWN"
"HAIR-SEAL-LOW-TIDE-TOWN" (ABUNDANCE OF HAIR SEALS AT LOW TIDE ALONG SHORES NEAR HERE) Ⓡ
Ⓔ "STRAIT-TOWN-WHERE-NO-WAVES-COME-ASHORE"
HOUSE ISLAND Ⓡ "ATA'NA"
Ⓡ "NARROW-STRAIT-VILLAGE"
HEREDITY RAVEN LINEAGE SITES Ⓡ
HEREDITY EAGLE LINEAGE SITES Ⓔ
GOWGAIA "BIG-BAY" SITES Ⓔ
Ⓔ "BAD-TALKING-VILLAGE" (THEY SAY 'BAD' THINGS ABOUT THE BOLKUS ISLAND PEOPLE)
"SWAMPY-VILLAGE"
Ⓡ JEDWAY
BOLKUS ISLAND "STRIPED-TOWN-VILLAGE" Ⓡ
GREATEST MOUNTAIN
Ⓡ "SONGS-OF-VICTORY"
"TOWN-INHABITED" Ⓡ
Ⓡ
"VILLAGE-DEEP-IN-INLET" Ⓡ
Ⓔ
Ⓡ "POINT-TOWN-VILLAGE-ALWAYS-SMELLING"
"TO-GO-FOR-CEDAR" Ⓡ + Ⓔ
Ⓡ
Ⓡ "VILLAGE-THAT-FISHES-TOWARD-THE-SOUTH"
"RED-COD-ISLAND-TOWN" Ⓔ
"SONGS-OF-VICTORY" Ⓡ
Ⓡ

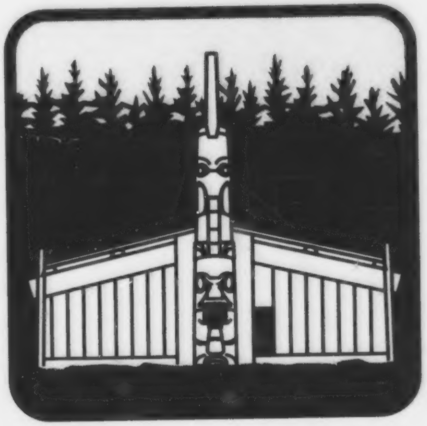
Figure 163. Some of the ancient Haida village and camping sites (after Danzell 1988).

B. TERRESTRIAL HISTORIC RESOURCES

It is with the foregoing prehistory in mind that one can begin to place the Haida and their unique culture into a contemporary historical setting.

In his treatise of the Indian history of British Columbia, Duff (1964) provided an important point about the Indians of that province, and in particular about the coastal tribes, that is often overlooked in the Canadian context, when he stated:

> **At the time of contact the Indians of this area were among the world's most distinctive people. Fully one-third of the native population of Canada lived here. They were concentrated most heavily along the coastline and the main western rivers, and in these areas they developed their cultures to higher peaks, in many respects, than in any other part of the continent north of Mexico. Here, too, was the greatest linguistic diversity in the country, with two dozen languages spoken, belonging to seven of the eleven language families represented in Canada.**
>
> **The coastal tribes were in some ways different from all other American Indians. Their languages, true enough, were members of American families, and physically they were American Indians, though with decided traits of similarity to the peoples of northeastern Asia. Their cultures, however, had a pronounced Asiatic tinge, evidence of basic kinship and long-continued contact with the peoples around the north Pacific rim. Most of all, their cultures were distinguished by a local richness and originality, the product of vigorous and inventive people in a rich environment.**



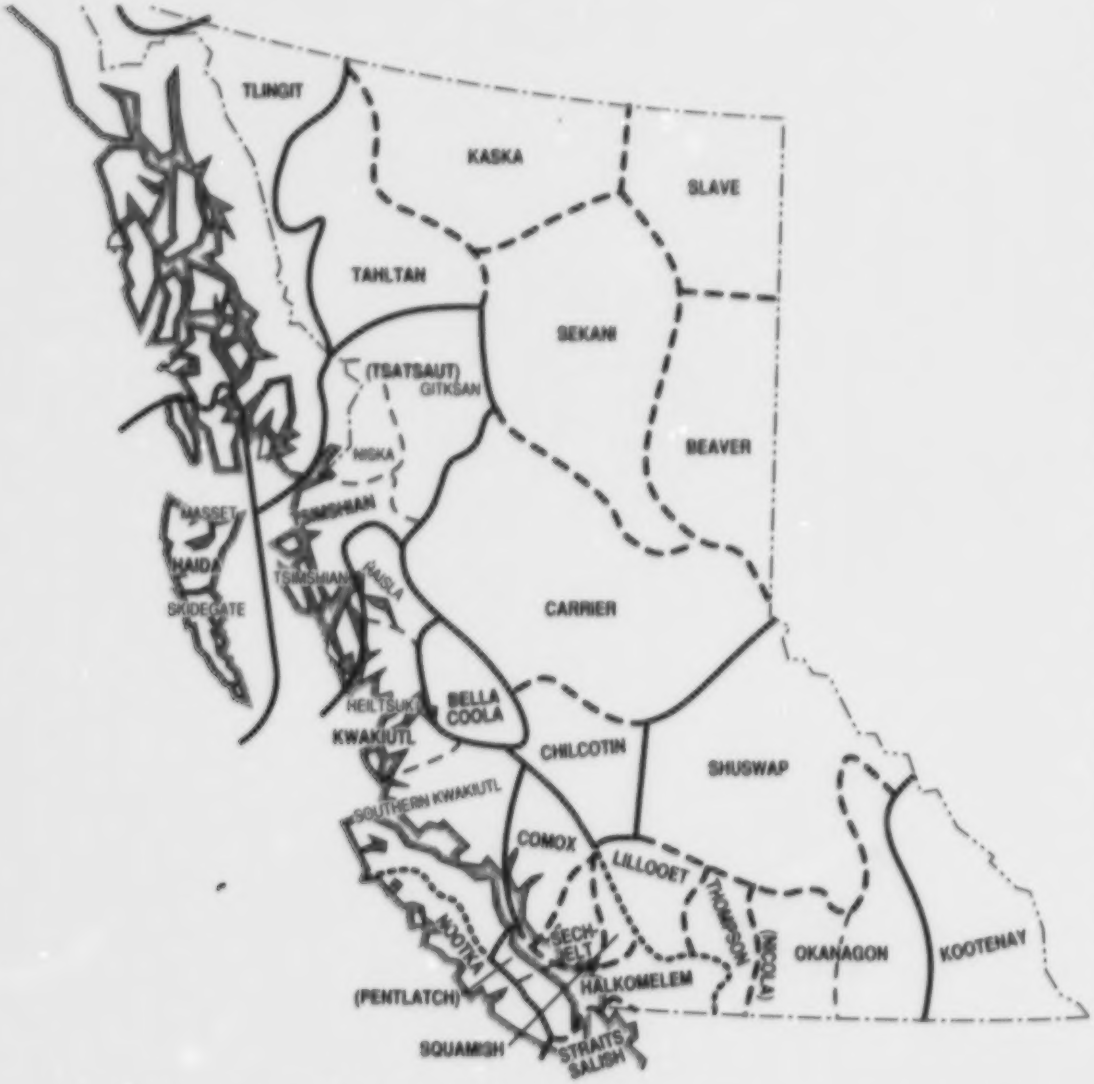

TLINGIT
KASKA
SLAVE
TAHLTAN
SEKANI
(TSATSAUT)
GITKSAN
NISKA
BEAVER
MASSET
HAIDA
SKIDEGATE
TSIMSHIAN
TSIMSHIAN
HAISLA
CARRIER
HEILTSUK
BELLA COOLA
KWAKIUTL
CHILCOTIN
SHUSWAP
SOUTHERN KWAKIUTL
COMOX
LILLOOET
THOMPSON
NOOTKA
SECH-ELT
(NICOLA)
OKANAGON
KOOTENAY
HALKOMELEM
(PENTLATCH)
SQUAMISH
STRAITS SALISH

Figure 164. Indians of British Columbia, linguistic subdivisions. Boldface indicates languages, while others are major dialects (after Duff 1964).

While it is not known when the Haida first came to the Queen Charlotte Islands to make their home there, it is well established when Europeans first made contact with them. As far as can be ascertained, their first sighting of the Islands was made by Spanish mariners of the Juan Perez expedition on the sailing ship "Santiago", on July 18th, 1774 (Gough 1989). Actual landfall was made by them the next day. In the years following, the Spaniard Juan Francisco de la Bodega y Quadra, the Englishman James Cook, and the Frenchman Comte de Laperouse, either visited or sighted the Queen Charlotte Islands as part of their larger exploratory expeditions. It was for Captain George Vancouver to conduct a preliminary coastal survey of the Islands in July and September of 1793, and to map a rough outline of the archipelago on British Admiralty charts (Gough 1989).

Yet it was not the explorers of the northwestern portions of the Pacific Ocean that examined and described the Islands, rather it was the British, French, and American maritime fur traders that visited them and the mainland coastline in the years between 1789 and 1820. George Dixon was the first European to provide a description of the archipelago, its environment, the Haida, and their material culture. It is of particular interest to note that he named the Islands after his ship, the Queen Charlotte (Gough 1989).

By all accounts, it would appear that the Haida were quick to take advantage of the trading opportunities that were presented to them, especially as far as the European demand for sea otter pelts were concerned. In this manner, foreign tobacco began to replace a locally grown variety, and sheet copper, iron, and distilled spirits became preferred items of trade. Boston whalers introduced the techniques of ivory carving which the Haida craftsmen in turn adapted to the carving of local argillite, eventually leading to considerable trade in carved art items. It has been suggested that the introduction of European trade brought about certain changes within the social structure of the Haida people: it increased general wealth, it promoted rivalry between chiefs and villages, and it stimulated artistic productivity. The relatively peaceful British trading dominance in the area held until about 1795, when American mariners from Massachusetts began to exert increasing trading pressure. Misunderstandings, the breaking of native customs, and cheating, eventually led to violence and bloodshed, where the fault lay "almost invariably" with the European traders (Gough 1989).

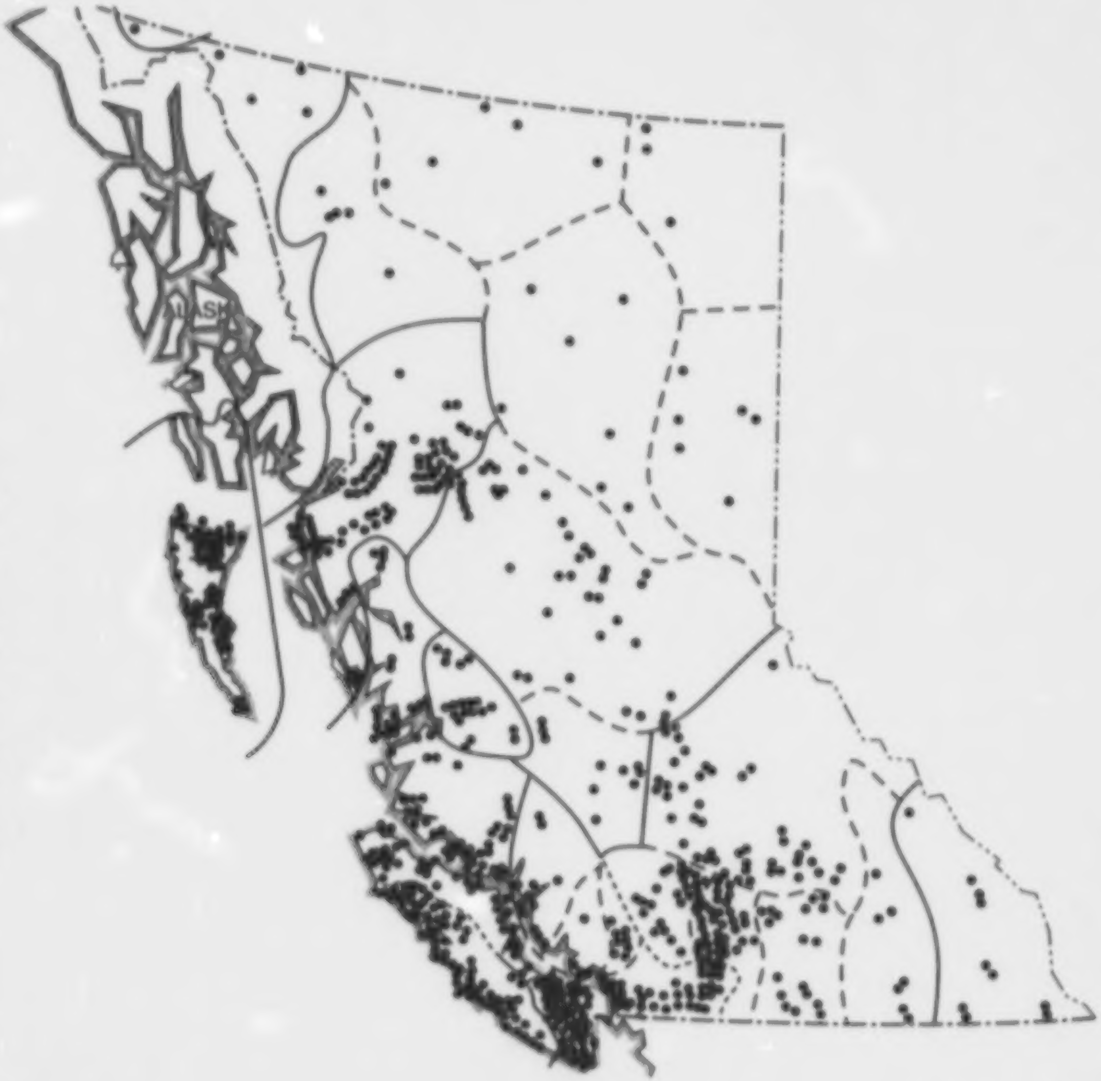


Figure 165. Indians of British Columbia, population distribution, 1885. One dot represents 100 people (after Duff 1964)

Eventually the sea-otter trade collapsed, and maritime traders rarely visited the Islands, until the Hudson Bay Company had firmly established itself in the region after eradicating both Russian and American competition from the area. Thus, the era of coastal trade between 1821 and 1851 was initiated, bringing with it relative stability to Haida history and their relations with Europeans. John Work, a Hudson Bay Company employee, was the first person to undertake a systematic census of the native peoples of the region, among them the Haida. His work established a Haida population of 6,593 persons for the years of 1836 to 1841 (Gough 1989). The figure quoted by Duff (1964) of 6,000 Haida for the year 1835, appears to be in reasonable agreement.

The introduction by Europeans of diseases no longer fatal to them, but lethal to the Indians who had no inherited resistance to them, brought about drastic and tragic population declines. The first epidemic of smallpox to devastate the people of the northern Pacific coast occurred during the 1780's and 1790's. The suffering involved was remembered by the Haida up to some forty years

Ethnic Division and Language:	*Dialect and Regional Groups:*	*Tribes and Bands (1850):*	*Name Given by Reserve Commission (1916):*	*Present Band Name and Population (1963):*
HAIDA **Haida**	MASSET DIALECT *Masset Inlet:*	Etawas Kayang Yan	Masset Tribe	Masset 903
	North Coast:	Kiusta and Kung Dadens Yaku		
	SKIDEGATE DIALECT *Skidegate Inlet and West Coast:*	Cathlingskun Skidegate Chaatl Kaisun } Haina 1870-98	Skidegate Tribe	Skidegate 321
	Moresby Island:	Cumshewa Skedans Tanoo (New Clew, 1885-97)		
	Kunghit Haida:	Ninstints		

Figure 166. Haida Indian tribes and bands, 1850 - 1963 (after Duff 1964).

later. There were several less severe recurrences of that epidemic along segments of the northern coast during 1836 and 1845. However, nothing could have prepared the Haida people for the devastation of their society that followed during 1862, when some of them returning from a visit to Victoria, British Columbia, returned as carriers of the dreaded smallpox disease. It has been suggested that population losses may have reached from 33 to 50 percent (Gough 1989). Smallpox was not the only disease being visited upon the Haida. Epidemics of measles, influenza, tuberculosis, venereal disease, the use of alcohol, and inter-tribal warfare, all contributed to not only the drastic decline of the Haida on the Queen Charlotte Islands, but also the Indian population of British Columbia on the whole.

The decimation of the various tribes and bands of the two Haida dialect groups was so severe that Duff (1964) reported a general contraction of their previously well dispersed numbers into two main bands, the Masset band with 903 souls, and the Skidegate band with only 321 souls, counted during the year 1863. This general population decline throughout the province was effectively checked by 1890 (by 1915 for the coastal Indian tribes). The lowest population point was reached circa 1929, when a census of the entire Indian population of British Columbia established them to number only 22,608 people (Duff 1964).

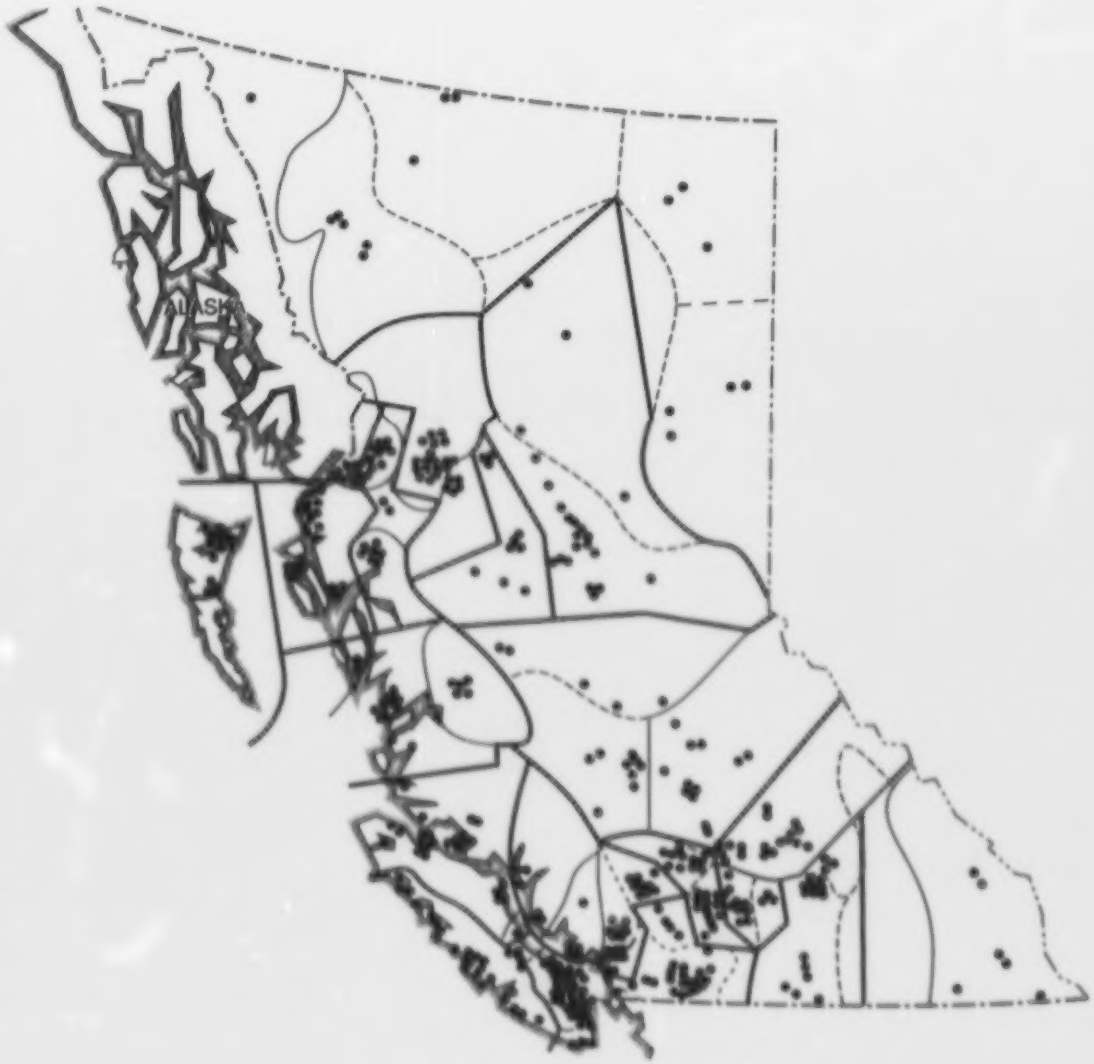


Figure 167. Indians of British Columbia, 1963. One dot represents 100 people. Heavy lines show Indian agencies (after Duff 1964).

The arrival of Anglican and Methodist missionaries during the 1880's served to further alter the traditional subsistance and settlement patterns of the Haida peoples. They quite voluntarily congregated around the Hudson Bay Store and the Anglican Church at Masset, but were encouraged by the Methodists to relocate to a new location at Skidegate. All this movement had for the most part, and by the turn of the last century, resulted in the abandonment of the old villages (Gough 1989). Previously common subsistence patterns also underwent change. While Anglican missionaries promoted horticulture as a substitute, the Methodists promoted the approach of broader economic pursuits as the way to a more prosperous life. Schools and coastal steamship services where introduced to the Islands during the same period of time (Gough 1989).

Since then, the population of the Haida people has stabilized and grown to its present size, and they have been able to retain a number of valuable linkages to their cultural past. They have shown a willingness to express their concerns publicly in the present more tolerant world setting. Regardless of this, the Haida will continue to interact nationally, socially, and economically with contemporary Canadian society: of which they are a valuable segment.

a) RESOURCE ANALYSIS

The archaeological and historical resources of the Queen Charlotte Islands in general, and the South Moresby / Gwaii Haanas National Park Reserve in particular, are not only unique in the national park context, but more importantly, in the much larger context of Canadian aboriginal history as well.

There are reasons to believe that the early human groups that came to inhabit the newly deglaciated landmass of what is now referred to as the northwestern Pacific coastal region of British Columbia, originated from a stock that had developed or shared common cultural and artistic traits. As the Haida people began to isolate themselves from their parent stock group(s) by emigrating from the mainland coast to islands off the coast, they also began to distinguish their cultural traits either through the process of cultural evolution, or through the influx of other cultural traits either acquired through travel to other cultural territories or brought to them by visiting groups from the Asian or North American continents. Isolated as they were, they created a rich cultural heritage, uniquely tailored to the environment in which they lived, the food resources available to them, and the societal requirements of their people. That heritage finds its expression today in the remains of their masterfully designed large wooden dwellings, their ornate totem poles and canoes, and their intricate wood and argillite carvings. The world community of man has recognized the cultural achievements and artistic contributions the Kunghit people of the Haida lineages have made to the world, even though they themselves did not survive the onslaught of European civilization, by declaring their former village of Ninstints a World Heritage Site under the auspices of the United Nations Educational, Scientific, and Cultural Organization.

As meetings between two totally different cultural human groups took place throughout time, the stronger of the two eventually imposed its values upon the weaker. The more than two-hundred years since Europeans first made contact with the Haida groups will serve to demonstrate that point. Smith (1984) provided the retrospective view that the first fifty years, from 1774 to 1825, of contact between our two groups did little to change the traditional patterns of the Haida people. The next fifty years, from 1825 to 1875, did bring about some societal changes, but did not disrupt or interrupt the "functioning whole" of their society. In fact, some traditional forms of their behaviour were stimulated, and there appear to have been no signs that acculturation was taking place. The introduction of fatal diseases, alcohol, and prostitution, not to mention continuing inter-tribal warfare, drastically affected and severely reduced the Haida population numbers during those years, but did not, according to Smith (1984), interfere with established traditions. However, the period following 1875 saw the occurrence of considerable and rapid changes in their traditional culture, with the result that by 1913, the Haida people that had survived were working for the Europeans, living *in their style of houses, professing to their religions, and sending Haida children to schools where they were taught European values. It must be acknowledged, though, that throughout the entire contact period, the relations between the native peoples of the Islands and the Europeans were characterized by "a high degree of mutual accommodation seldom realized in contact situations" (Smith 1984).*

Throughout that period of time, the Haida people have been able to maintain their self-respect and personal autonomy due to their superiority in the fishing occupation (Smith 1984). There is every reason to believe that because of their cultural uniqueness, they will continue to contribute strongly to the Canadian cultural mosaic as this nation approaches the 21st Century.

- Management Concerns

Three management concerns present themselves readily:

1.) The Canadian Parks Service must for mutually advantageous reasons continue to work towards an integration of the traditional and cultural aspirations of the Haida people into its own long-range program for the South Moresby/ Gwaii Haanas National Park Reserve.

2.) A long-term archaeological and ethnographic research program needs to be initated, so that in time it may serve to establish a full understanding of the cultural attributes of the area in the national park reserve and its past and present peoples, in order that future park developments may enhance rather than do damage to theretofore unknown native cultural sites, artifacts, and traditions.

3.) The Ninstints Village - World Heritage Site responsibilities inherited from the government of British Columbia, must be discharged in keeping with the National Parks Act and the conventions of the United Nations Organization.

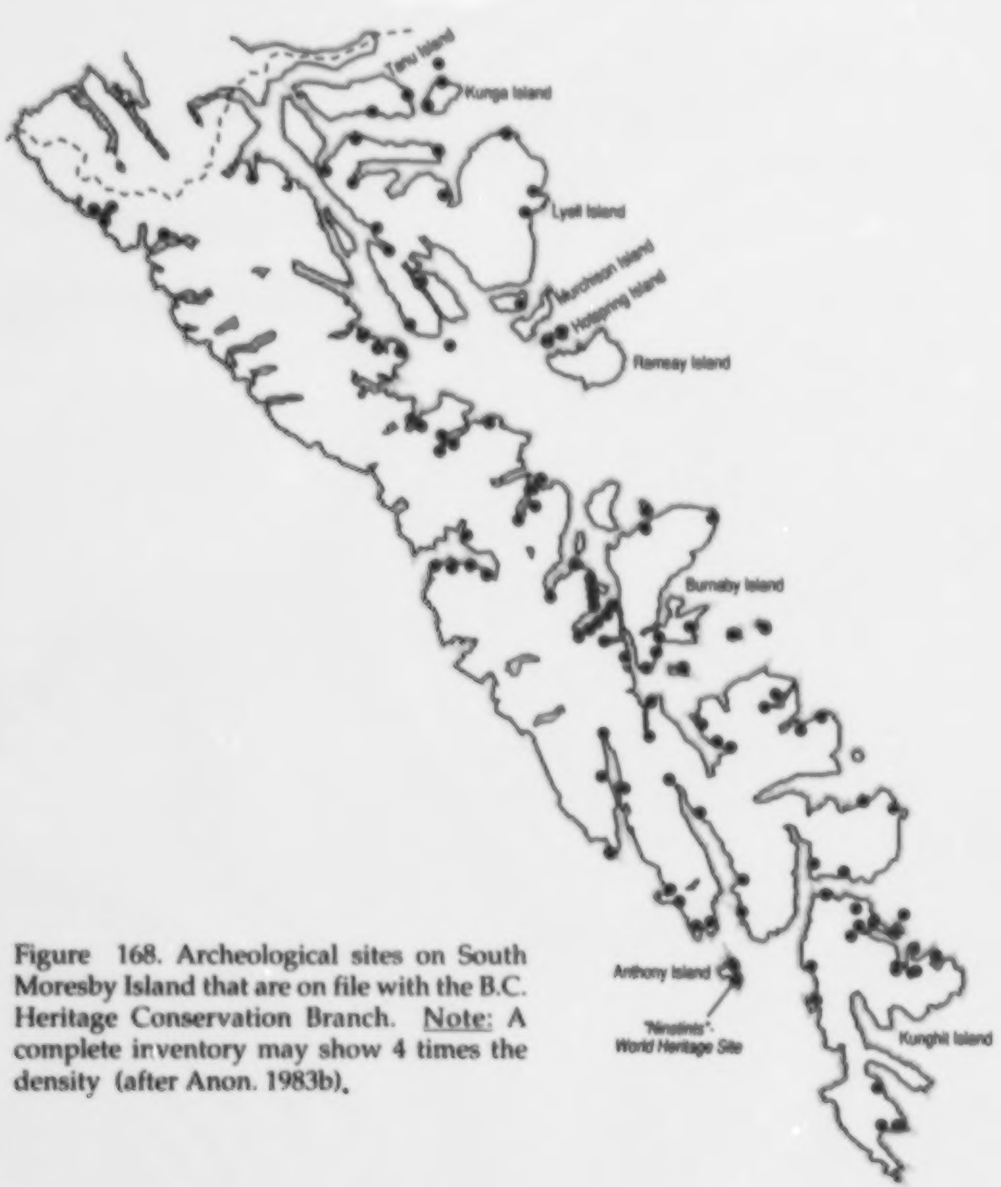

Tanu Island
Kunga Island
Lyell Island
Murchison Island
Hotspring Island
Ramsay Island
Burnaby Island
Anthony Island
"Ninstints" World Heritage Site
Kunghit Island

Figure 168. Archeological sites on South Moresby Island that are on file with the B.C. Heritage Conservation Branch. Note: A complete inventory may show 4 times the density (after Anon. 1983b).

- Status of Knowledge

The current level of archaeological and ethnographic knowledge is certainly sufficient to allow park management planning to submit a range of broad protective and developmental organizational aims to the citizens of this country for national discussion and general public input.

However, and as already expressed above, before any infrastructural developments actually take place in areas that are known or suspected to be of heritage significance, appropriate levels of research must first be initiated so that modern developments will enhance rather than obliterate the endemic heritage resources, as well as contribute to the collective knowledge of mankind.

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B. MARINE ARCHAEOLOGICAL & HISTORIC RESOURCES

There are two types of archaeological and historical resources to be found within the marine environment of South Moresby Island: the cultural remnants of Haida occupation along the shoreline, and the wrecks of ships beneath the sea.

Without reiterating the history of the native people as described earlier in this chapter, it is possible to distinguish a number of historically important marine archaeological sites by relying largely on the work of Hobler (1978) and Fladmark (1989). Fladmark (1986) has, as well, told the comprehensive story of British Columbian prehistory.

Many archaeological sites on the Queen Charlotte Islands are marine in nature only by virtue of the historical changes in sea levels. During the Pleistocene, prior to approximately 10,000 years ago, sea levels were lower than present because of the fact that eustatic drawdown of the sea level due to glaciation dominated over the isostatic loading of the land by glaciers (Clague 1989). During the later deglaciation stages of the Holocene, however, the sea level rose to a level of about 15 metres above the present sea level by about 9,500 B.P. The high water level persisted to about 4,500 B.P., after which the level declined steadily to its present level (Fladmark 1989). If there were any evidence of habitation prior to 10,000 B.P., it may now be buried beneath the sea, inaccessable to conventional archaeology. If, as Hobler (1978) suggests, the re-emergence of the land is an on-going phenomenon, new evidence of early occupation may yet uncover.

Between them, Fladmark (1989), Hobler (1978), and Searing & English (1983) have noted the location of eleven major archaeological sites on South Moresby which are associated with the intertidal zone and a further two sites which are associated with higher water. Of the intertidal sites, the two in the innermost reaches of Heater Harbour on Kunghit Island and the one at the head of Hutton Inlet on Moresby Island itself, are sites of fish traps (Searing & English 1983) which, because of their association with present sea levels, makes it likely that they are not very old (Fladmark 1986).

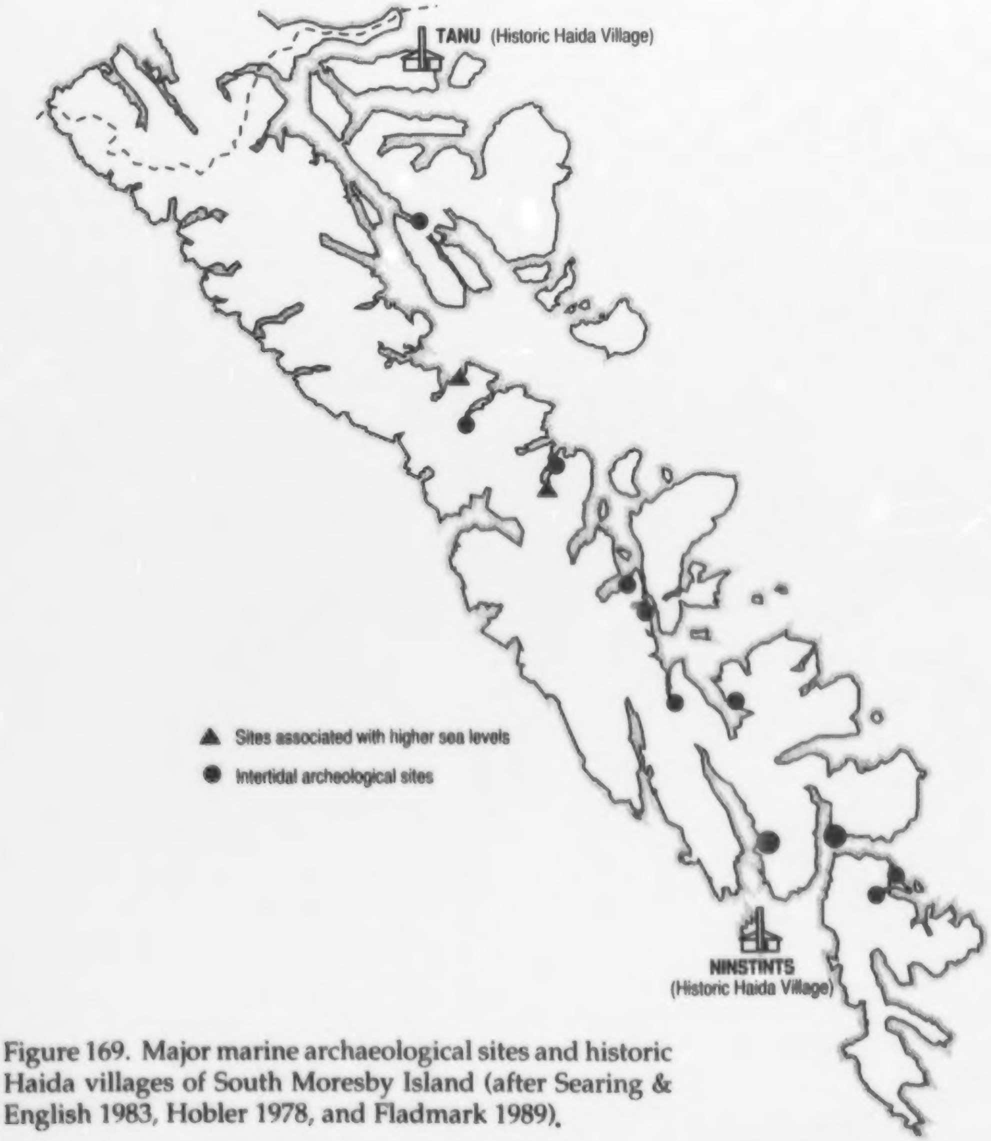
TANU (Historic Haida Village)
Sites associated with higher sea levels
Intertidal archeological sites
NINSTINTS
(Historic Haida Village)

Figure 169. Major marine archaeological sites and historic Haida villages of South Moresby Island (after Searing & English 1983, Hobler 1978, and Fladmark 1989).

The majority of the intertidal archaeological sites, those identified by Hobler (1978), contain only artifacts of water-tumbled andesite pebble-cores and flakes that are quite different in construction from those of the later Moresby Tradition which began about 8,000 B.P. (Fladmark 1989). An earlier culture than the Moresby Tradition may not have existed much before 9.000 B.P. since the sea level during the late Pleistocene may have been as much as 30 metres lower than present, and the rise to 10 metres above the present levels apparently took place quickly (Hobler 1978). Sites associated with lower sea levels tend to be in small, well-sheltered bays, and what surficial artifacts have been discovered (largely in the upper half of the intertidal zone) appear to have originally been deposited on land when the sea was 2-5 metres lower than its present level (Hobler 1978).

Sites associated with higher sea levels are hard to locate except in areas where activity has exposed the soil. Hobler (1978) found eight such sites on Moresby Island, two of which fall within the boundaries of the national park reserve. The technology of the artifacts found at sites associated with higher sea levels is akin to that of similar sites on Graham Island. On Moresby Island, the sites associated with higher sea levels show evidence of smaller stone flakes and the microblade manufacture so characteristic of the Moresby Tradition.

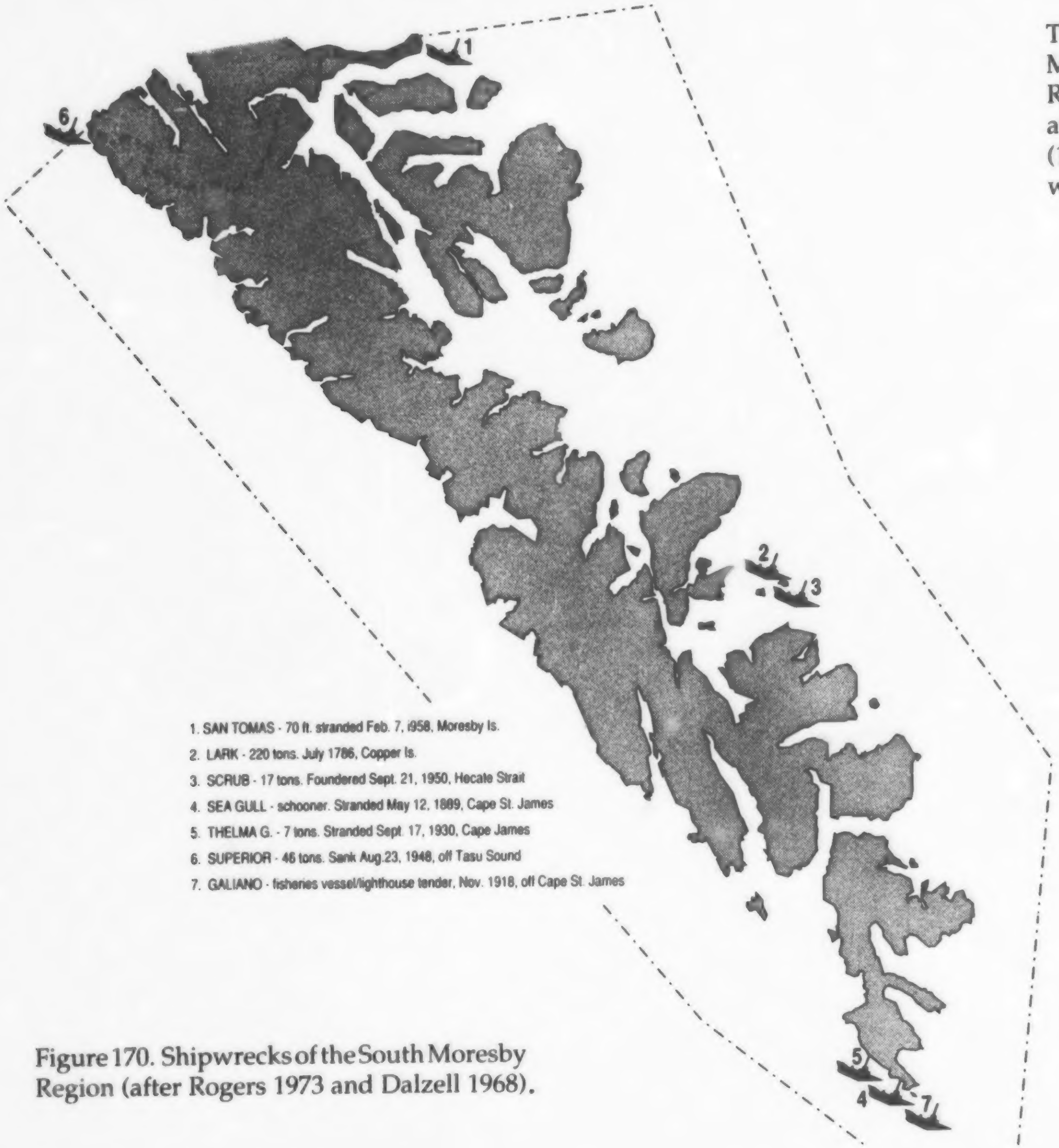
1
6
2
3
5
4
7
1. SAN TOMAS - 70 ft. stranded Feb. 7, 1958, Moresby Is.
2. LARK - 220 tons. July 1786, Copper Is.
3. SCRUB - 17 tons. Foundered Sept. 21, 1950, Hecate Strait
4. SEA GULL - schooner. Stranded May 12, 1889, Cape St. James
5. THELMA G. - 7 tons. Stranded Sept. 17, 1930, Cape James
6. SUPERIOR - 46 tons. Sank Aug.23, 1948, off Tasu Sound
7. GALIANO - fisheries vessel/lighthouse tender, Nov. 1918, off Cape St. James

Figure 170. Shipwrecks of the South Moresby Region (after Rogers 1973 and Dalzell 1968).

The history of shipwrecks in the South Moresby region is sparsely documented. Rogers (1973) records only six wrecks in the area, of which four are 1930 or later. Dalzell (1968) provides one more record of a 1918 wreck.

a) RESOURCE ANALYSIS

Marine-associated archaeological sites on Moresby Island offer the important possibility of confirming the existence of a culture prior to the Moresby Tradition. Fladmark (1989) suggests that it is at present a reasonable inference that certain of the south Moresby intertidal assemblages pre-date 10,000 years B.P. He goes on to say that one reason that so many such assemblages are concentrated in the south Moresby area may be that the minimum post-glacial sea level in that area 100,000 years ago and earlier lay within the present tidal zone, while further north, such assemblages are now about 20 metres below lower low tide. Confirmation of that thesis must await the complex and expensive underwater archaeological exploration of the submerged strandlines and stream channels of the Hecate Strait.

There are few known shipwrecks within the south Moresby area only three of which occurred prior to 1930.

- Management Concerns

Marine archaeological knowledge is difficult, expensive, and time-consuming to gather. The marine environment imposes special limitations in terms of public safety, manoeuvreability, life support systems, marine weather, pressures at depth, and visibility. Even those archaeological sites associated with a once higher water level are difficult to find and to explore due to the prolific nature of the vegetation.

There is a need to document the marine archaeological heritage as fully as possible prior to the increased introduction of visitors into the area. There must also be a visitor education program encouraging people to preserve the archaeological heritage in situ rather than collecting specimens, whether those be artifacts of pre- or post-contact heritage.

Jurisdiction and title over shipwrecks and their contents must be clearly established so as to avoid possible future contention by would-be salvors.

- Status of Knowledge

The 1974-1975 archaeological survey by Hobler (1978), which was the first systematic archaeological survey of Moresby Island (Fladmark 1989), saw three-quarters of the research effort devoted to the east coast of Moresby Island, with the remainder being spent on the less populated and hard to travel west coast. Consequently, the 99 new sites which he found are mainly on the east coast. Much more work could be and needs to be done on the west coast, and the relationship of archaeological sites to sea level can build upon the work of Hobler (1978).

The knowledge of shipwreck sites in the area of the Queen Charlotte Islands is quite limited due to their remote position during the earlier days of vessel traffic. The sole reference is Rogers (1973).

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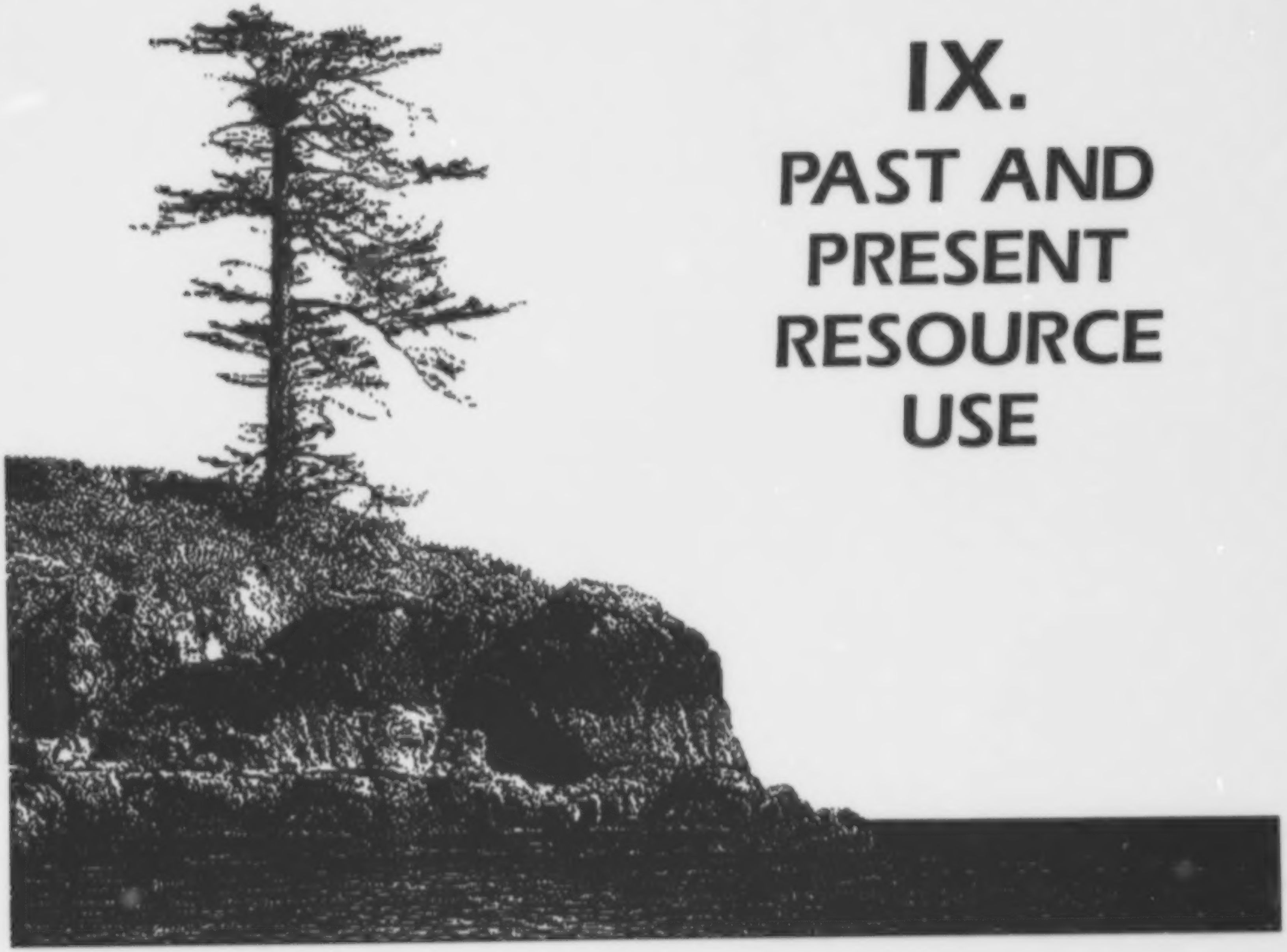
IX.

PAST AND PRESENT RESOURCE USE

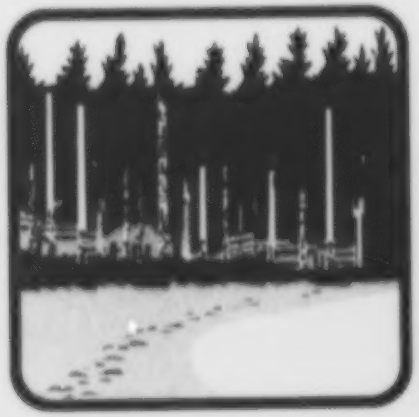


PAST & PRESENT RESOURCE USE

- General Overview

In the context of the modern usage of the term "resource use", it was the European sailors, fur traders and entrepreneurs that first introduced the concept and activities associated with "resource use for economic gain" to the native people of the Queen Charlotte Islands, somewhat more than two-hundred years ago. Prior to that time, the full extent of the use of natural resources by the Haida people appears to have been restricted to the occupation of a number of relatively small openings in the forest at protected shoreline vantage points. There they erected villages or camps of various sizes and commenced to harvest from the sea no more than they required to feed themselves. They felled select trees within the nearby forest stands for building timbers, the carving of totem poles, and hollowing out canoe hulls.

As the Queen Charlotte Islands were visited more frequently during the years following 1774 by the various representatives of several European trading nations in political and economic competition with one another, resource exploitation for economic gain began to increase in prominance. Following the years when smallpox and other diseases had ravaged the various Haida villages of the Eagle and Raven lineages, a contraction of the surviving peoples took place that centred around village locations of Masset and Skidegate on Graham Island, leaving Moresby Island with nothing but the history of abandoned native villages. It is perhaps this fact above all others, that caused earlier and more extensive and intensive patterns of exploration, exploitation, settlement, and trade to develop on Graham Island, while the development of the same activities at the same intensity levels lagged behind somewhat on Moresby Island.



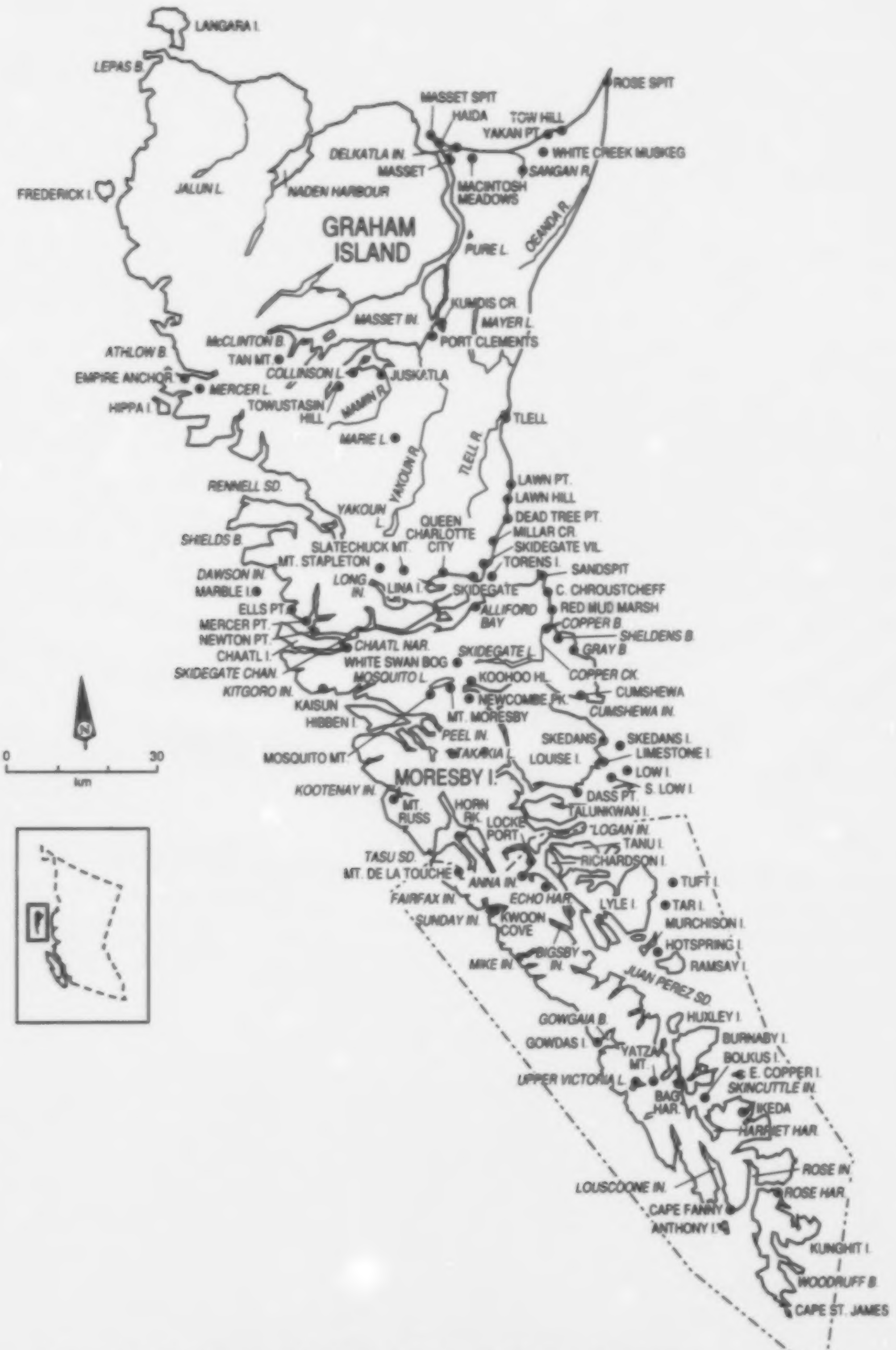

LANGARA I.
LEPAS B.
ROSE SPIT
MASSET SPIT
HAIDA
TOW HILL
YAKAN PT.
DELKATLA IN.
WHITE CREEK MUSKEG
MASSET
SANGAN R.
FREDERICK I.
JALUN L.
NADEN HARBOUR
MACINTOSH MEADOWS
GRAHAM ISLAND
OEANDA R.
PURE L.
KUMDIS CR.
MASSET IN.
MAYER L.
McCLINTON B.
PORT CLEMENTS
ATHLOW B.
TAN MT.
EMPIRE ANCHOR
COLLINSON L.
JUSKATLA
MERCER L.
HIPPA I.
TOWUSTASIN HILL
MAMIN R.
TLELL
MARIE L.
YAKOUN R.
TLELL R.
LAWN PT.
LAWN HILL
RENNELL SD.
YAKOUN L.
QUEEN CHARLOTTE CITY
DEAD TREE PT.
MILLAR CR.
SHIELDS B.
SLATECHUCK MT.
SKIDEGATE VIL.
MT. STAPLETON
TORENS I.
DAWSON IN.
SANDSPIT
LONG IN.
LINA I.
SKIDEGATE
MARBLE I.
C. CHROUSTCHEFF
RED MUD MARSH
ELLS PT.
ALLIFORD BAY
COPPER B.
MERCER PT.
NEWTON PT.
SHELDENS B.
CHAATL NAR.
CHAATL I.
SKIDEGATE L.
GRAY B.
WHITE SWAN BOG
SKIDEGATE CHAN.
MOSQUITO L.
KOOHOO HL.
COPPER CK.
CUMSHEWA
KITGORO IN.
KAISUN
NEWCOMBE PK.
CUMSHEWA IN.
HIBBEN I.
MT. MORESBY
PEEL IN.
SKEDANS
SKEDANS I.
MOSQUITO MT.
TAKAKIA L.
LOUISE I.
LIMESTONE I.
MORESBY I.
LOW I.
S. LOW I.
KOOTENAY IN.
DASS PT.
MT. RUSS
HORN PK.
TALUNKWAN I.
LOCKEPORT
LOGAN IN.
TANU I.
TASU SD.
RICHARDSON I.
MT. DE LA TOUCHE
ANNA IN.
TUFT I.
FAIRFAX IN.
ECHO HAR.
LYLE I.
TAR I.
SUNDAY IN.
KWOON COVE
MURCHISON I.
HOTSPRING I.
MIKE IN.
BIGSBY IN.
RAMSAY I.
JUAN PEREZ SD.
GOWGAIA B.
HUXLEY I.
GOWDAS I.
YATZA MT.
BURNABY I.
BOLKUS I.
E. COPPER I.
UPPER VICTORIA L.
BAG HAR.
SKINCUTTLE IN.
IKEDA
HARRIET HAR.
ROSE IN.
LOUSCOONE IN.
ROSE HAR.
CAPE FANNY
ANTHONY I.
KUNGHIT I.
WOODRUFF B.
CAPE ST. JAMES
N
0
30
km

Figure 171. The Queen Charlotte Islands and their place names.

In the case of the area encompassed by the South Moresby / Gwaii Haanas National Park Reserve, and setting early marine fur-trading contacts with the Haida people aside, the truly consumptive resource use era did not commence on Moresby Island until about the last two decades of the past century when mining, whaling, fish processing, forest extraction, and recreation activities were first introduced (Anon. 1983b).

Interestingly enough, the earliest known mining development took place at Mitchell Inlet in 1852, and is credited with being instrumental in causing the Queen Charlotte Islands to be declared a Crown Colony by 1853. Several commercially attractive mining ventures flourished on Moresby Island, the last of which, the Jedway Mine, closed its operations in 1968, when the orebody is said to have been exhausted after producing two million tons of ore for Japanese smelters. The latest commercial explorations known to have occurred were carried out in 1988 in the vicinity of the remnants of the now derelict town of Lockeport (Anon. 1983b).

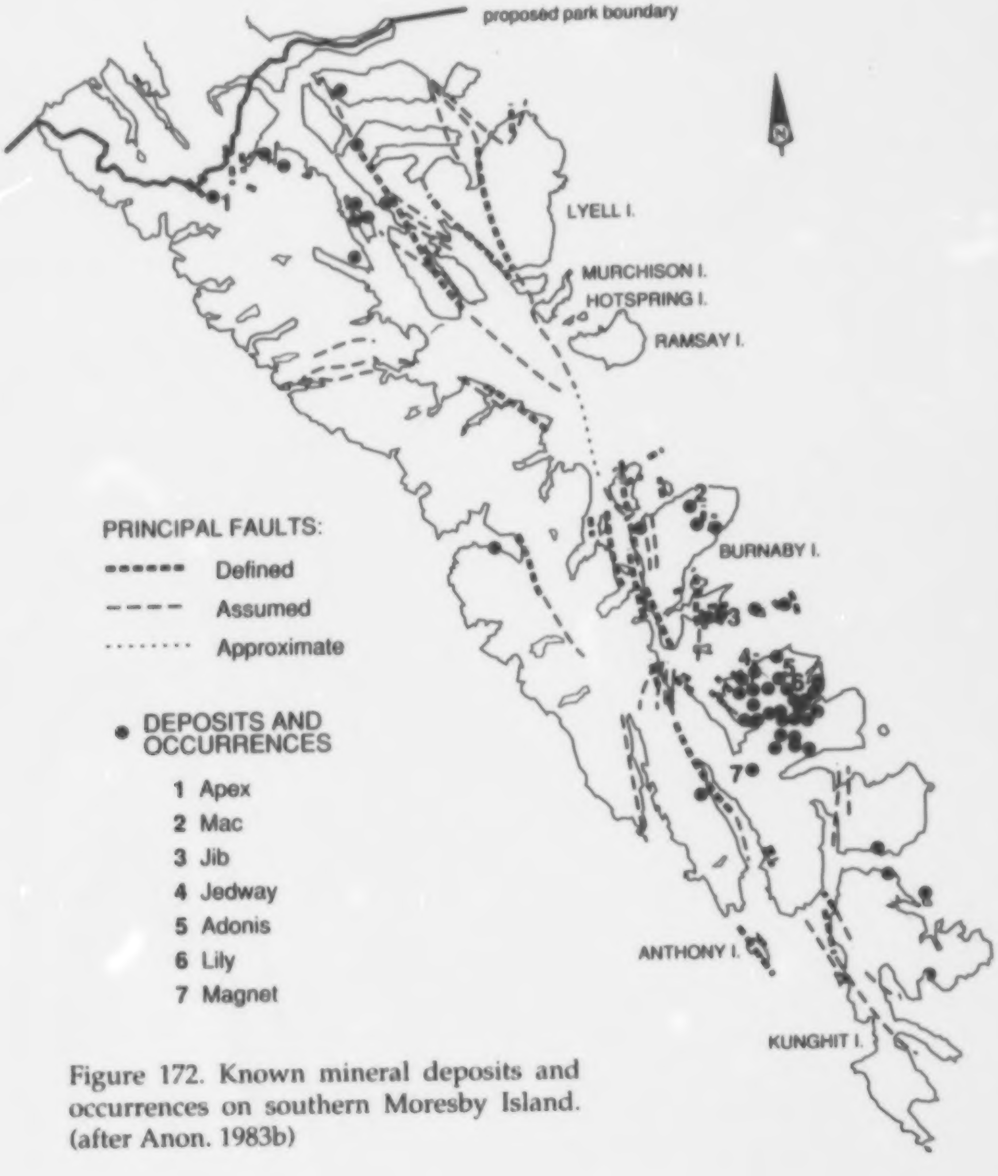

proposed park boundary
N
LYELL I.
MURCHISON I.
HOTSPRING I.
RAMSAY I.
BURNABY I.
ANTHONY I.
KUNGHIT I.
1
2
3
4
5
6
7
PRINCIPAL FAULTS:
------ Defined
- - - - Assumed
.... Approximate
● DEPOSITS AND OCCURRENCES
1 Apex
2 Mac
3 Jib
4 Jedway
5 Adonis
6 Lily
7 Magnet

Figure 172. Known mineral deposits and occurrences on southern Moresby Island. (after Anon. 1983b)

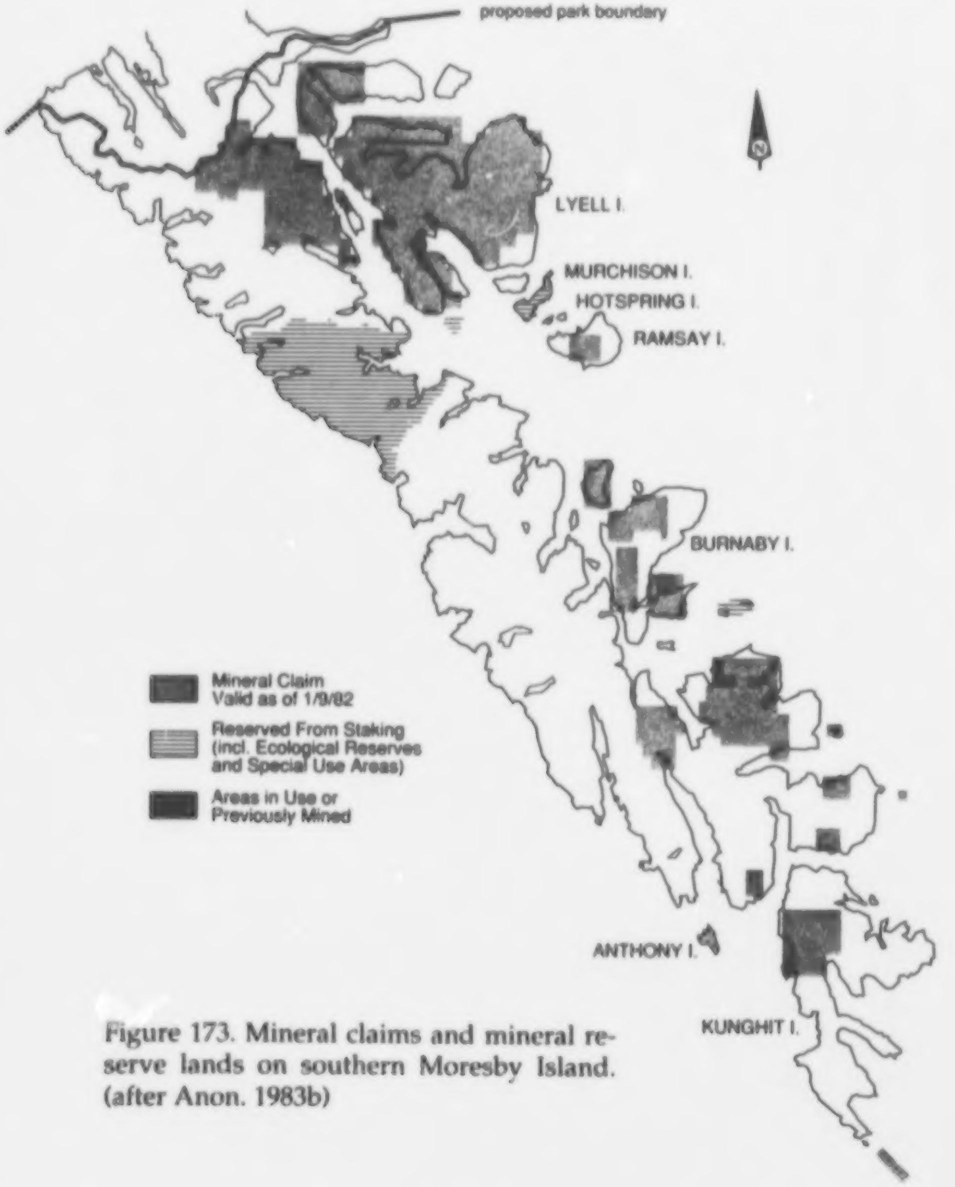

proposed park boundary
LYELL I.
MURCHISON I.
HOTSPRING I.
RAMSAY I.
BURNABY I.
ANTHONY I.
KUNGHIT I.
N
Mineral Claim Valid as of 1/9/82
Reserved From Staking (incl. Ecological Reserves and Special Use Areas)
Areas in Use or Previously Mined

Figure 173. Mineral claims and mineral reserve lands on southern Moresby Island. (after Anon. 1983b)

Whaling operations on the other hand, commenced on Moresby Island with the construction of a processing station at Rose Harbour. It operated there successfully between 1910 and 1943 (Anon. 1983b). There are presently no whale processing stations either in existence or operating within the national park reserve on South Moresby Island.

Fish processing and salmon canning became important commercial activities early in the 20th Century. A small abalone cannery operated on Murchison Island as early as 1913. In the years following 1926, an abalone cannery and several Japanese salteries operated in the general area of Jedway. A fish cannery was constructed at Lockeport and operated intermittently for the decade between 1918 and 1928 (Anon. 1983b). There are presently no fish processing or cannery stations either in existence or operating within the national park reserve on South Moresby Island.

Logging activities began on Moresby Island very early in the present century. A small logging and sawmilling operation produced the timber required to construct the community of Jedway around 1910. Camps were established in the northern portions of Moresby Island during the First World War to log high quality spruce trees for airplane construction purposes. Between the mid-1920's and the mid-1940's, three major logging companies operated on Lyell, Tanu, Richardson, Kunga, Shuttle, Murchison, Faraday, Huxley, and Burnaby Islands. They removed prime timber resources from over 5,000 hectares of land (Anon. 1983b). All logging operations have ceased since the South Moresby / Gwaii Haanas National Park Reserve was created by mutual agreement between the province of British Columbia and the federal government of Canada. In the case of Lyell Island, land and forest rehabilitation activities have already commenced, following a review of the existing conditions under the auspices of the federal Environmental Assessment & Review Process (EARP).

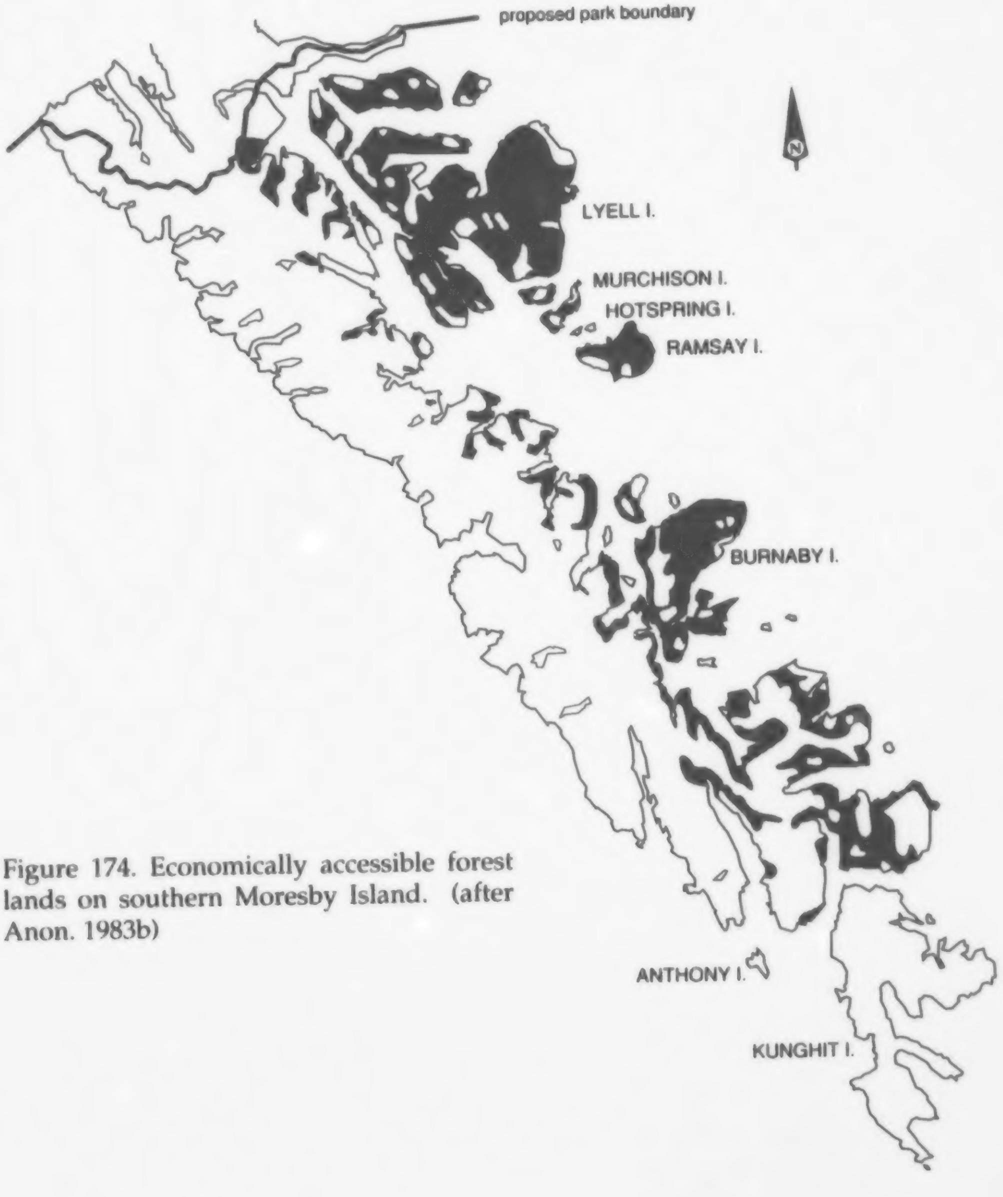

proposed park boundary
N
LYELL I.
MURCHISON I.
HOTSPRING I.
RAMSAY I.
BURNABY I.
ANTHONY I.
KUNGHIT I.

Figure 174. Economically accessible forest lands on southern Moresby Island. (after Anon. 1983b)

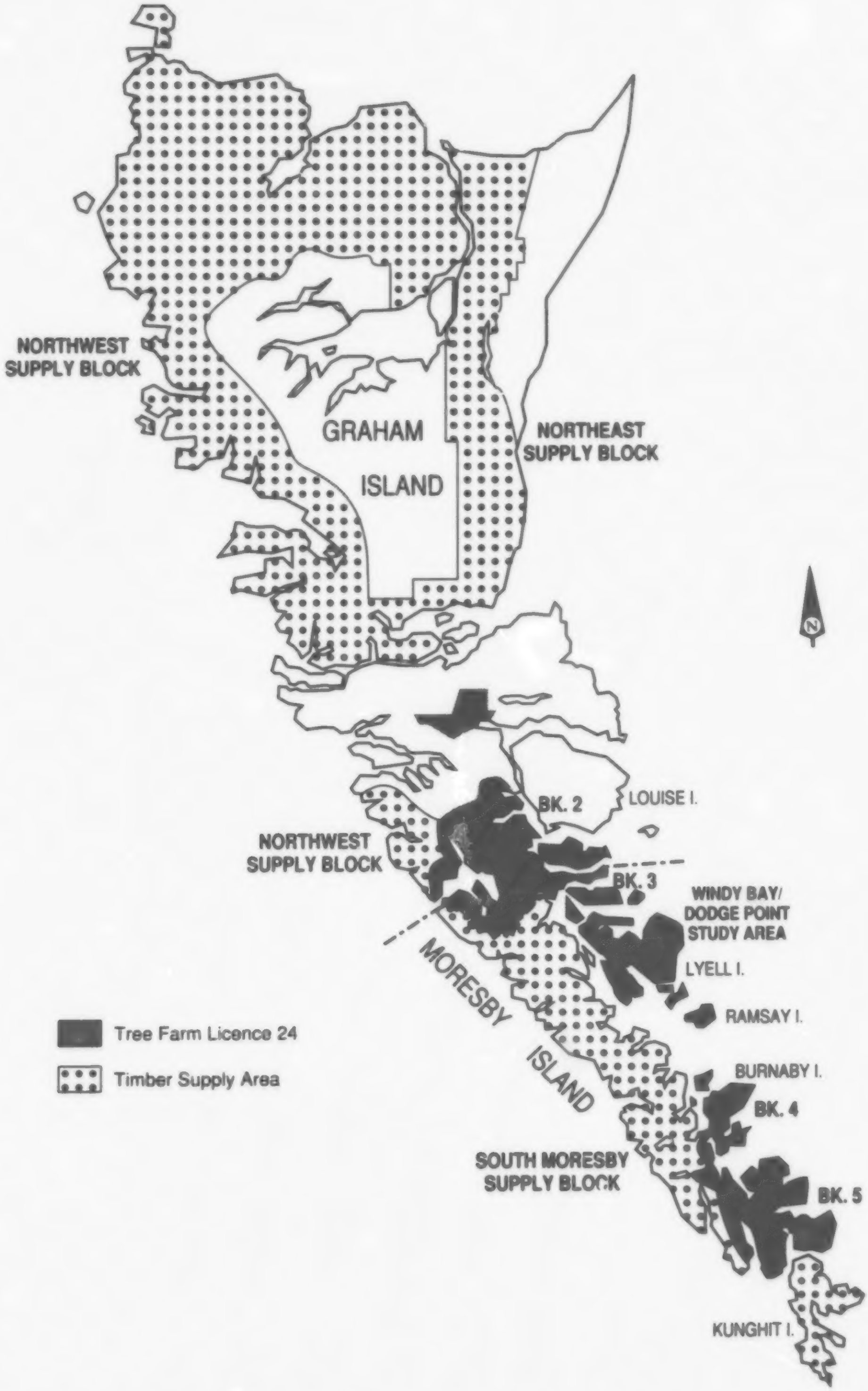
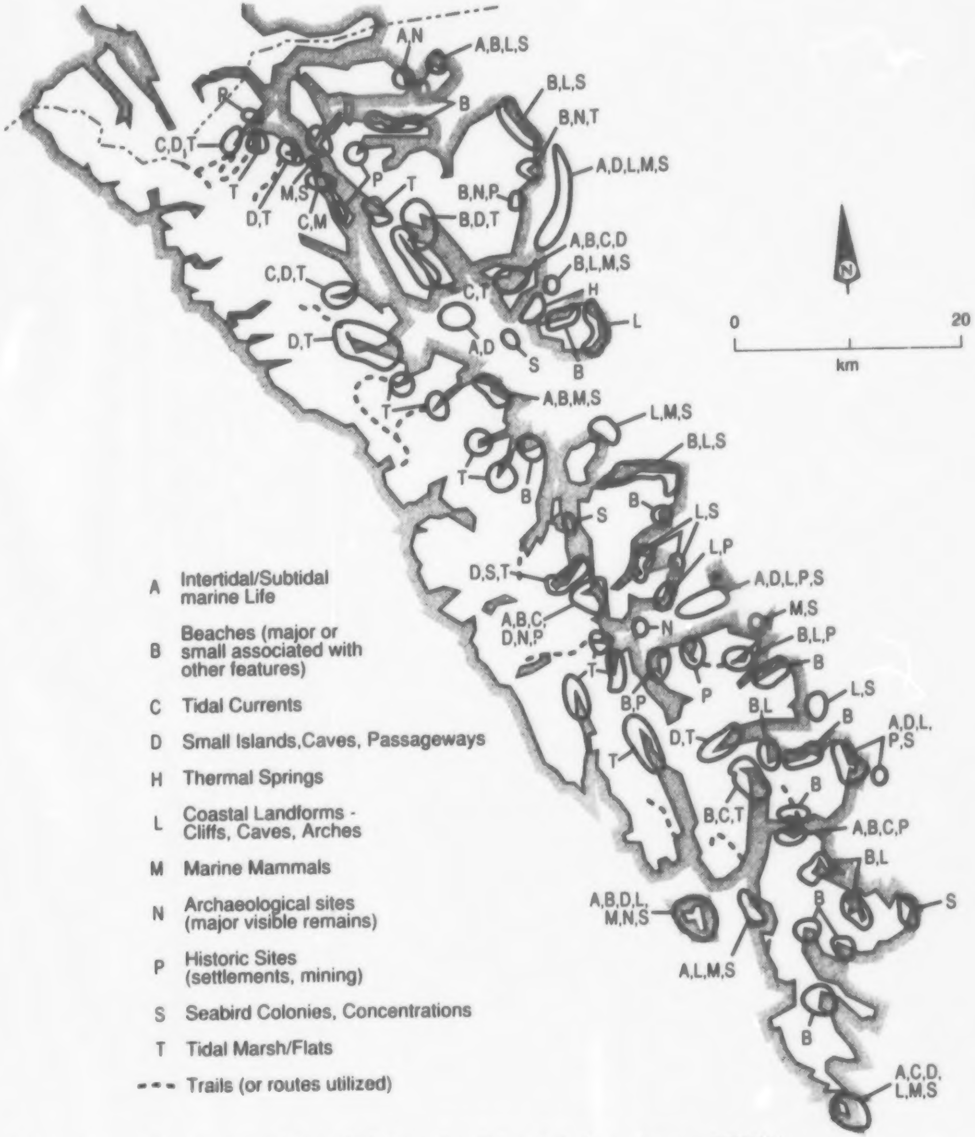

NORTHWEST SUPPLY BLOCK
GRAHAM ISLAND
NORTHEAST SUPPLY BLOCK
N
LOUISE I.
BK. 2
NORTHWEST SUPPLY BLOCK
BK. 3
WINDY BAY/ DODGE POINT STUDY AREA
MORESBY ISLAND
LYELL I.
RAMSAY I.
Tree Farm Licence 24
Timber Supply Area
BURNABY I.
BK. 4
SOUTH MORESBY SUPPLY BLOCK
BK. 5
KUNGHIT I.

Figure 175. Timber supply designations for actual and potential logging activities on the Queen Charlotte Islands, 1983. (after Anon. 1983b)

While it can not be ascertained with accuracy when recreation activities were first introduced to Moresby Island, the safe assumption can be made that much of the early exploratory commercial activities were either the result of, or were subsequently spawned by, activities that in themselves contained a high degree of recreational appeal to the individuals that carried them out. Europeans have always been adventurous and most curious about the new areas and environments in which they found themselves. Admittedly, that was a different kind of recreation activity than we ascribe to the title today; nevertheless, it was the accepted and therefore valid form of "recreation" of that time period. It was through those exploratory recreation activities that places such as Ninstints and Hotsprings Island were first noted, or rediscovered by Europeans, and finally enjoyed for their various and often different recreational values. In due course, the Canadian Parks Service will have to study, document, and evaluate the full range of the existing recreation potential of its new national park reserve on South Moresby Island in order to plan for its best benefit to Canadians. Any presently active, proposed, and future, terrestrially-oriented recreation activities and related developments, will have to first take under consideration the protection and preservation mandate of Canadian Parks Service for all of the physical, biological, and human heritage values under its jurisdiction.


A,N
A,B,L,S
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B
B,N,T
A,D,L,M,S
C,D,T
P
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M,S
D,T
C,M
P
T
B,N,P
B,D,T
A,B,C,D
B,L,M,S
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C,T
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L,M,S
B,L,S
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A,D,L,P,S
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B,L
A,B,D,L,M,N,S
B
S
A,L,M,S
B
A,C,D,L,M,S
A Intertidal/Subtidal marine Life
B Beaches (major or small associated with other features)
C Tidal Currents
D Small Islands,Caves, Passageways
H Thermal Springs
L Coastal Landforms - Cliffs, Caves, Arches
M Marine Mammals
N Archaeological sites (major visible remains)
P Historic Sites (settlements, mining)
S Seabird Colonies, Concentrations
T Tidal Marsh/Flats
--- Trails (or routes utilized)

Figure 176. Recreational features of South Moresby Island (after Anon. 1983b)

A. TERRESTRIAL RESOURCE USE

Resource extractive activities on Moresby Island commenced somewhat later than they had on Graham Island, and they were never as extensive, though their intensity in the areas affected was equally dramatic. For the purpose of providing a brief description of the documented extent of commercial development and resource extractive activities that where visited upon Moresby Island, the work of Kathleen E. Dalzell (1983b, 1988) is referred to herein as the authority.

Northwest Coast, Moresby Island:

1851- 1939. Gold was first found and extracted in small amounts on a hilly shoreline along the west side of Mitchell Inlet and at Una Point. Intermittent extraction activities continued throughout the subsequent years with varying levels of success. A stamp mill was imported in 1907. Operations ceased in 1939. In all, 16 mining claims were filed.

1908-1909. An eight mile long trail was cut by government order to provide access and egress to and from the gold mine at Mitchell Inlet to Security Inlet on the south shore of Skidegate Channel.

1909. J. Borthwick and A. Duval of Queen Charlotte City excavated a 20 foot long mining tunnel at Lena Lake which was eventually abandoned.

West Coast, Moresby Island:

1884 - . Newton Chittenden, on his exploratory trip for the British Columbia government, crossed the central mountain range on an ancient Haida portage route and trail from Hutton Inlet to Gosky Bay within Gowgaia Bay.

1907 - 1908. Prospecting began at and near-Tasu Sound, and trails were cut under government authorization, one along the old "Thlcaggans Cass" complete with corduroy and a cabin at each end; another along Flat Creek to the head of Crescent Inlet, where it joined a third trail that led to Lockeport. A less official trail was partly constructed and partly blazed from Lockeport past Anna Lake and Apex Mountain to the head of Botany Bay on Tasu Sound.

1907 - 1908. Hawkins Edwards staked and briefly worked a small mining claim along Edwards Creek which flows into Two Mountain Bay.

1913 - 1930's. G. Chapman first owned and operated a surface mine, called the Hydah Gold Mine, along the east side of the south arm of Kootenay Inlet. The claims making up the property were worked "spasmodically" over the years by different owners.

1908 - 1983. Henry Moody of Skidegate made the first significant ore discovery on Mount Tasu. He sold his holdings to the Elliot Mining Company in 1909. Following years of prospecting and financial dealings, this later became the Westfrob-Falconbridge Mines Ltd. In connection with this venture, a townsite for approximately 400-500 persons was built on Gowing Island.This iron-copper-gold-silver-producing mine operated at high capacity from 1968 to 1983, and stands now abandoned.

1911 - 1913. The Queen Charlotte Fishing Company established a small fishing station and boat building plant at Two Mountain Bay on the northeast side of Tasu Sound.

1924 - . A survey map prepared by A.E. Wright indicated that a trail had been built from Wilson Bay south of Barrier Bay and via Crescent Bay to Lockeport.

1939 - 1945. The Royal Canadian Air Force maintained a small outpost near the old Haida village of Tcuga near the mouth of Gowgaia Bay. A cabin was erected, and abandoned at the end of the war.

1963 - . Present. Neil and Betty Carey constructed a small homestead at Puffin Cove about 4 kilometres south of Mike Inlet. They reside there intermittently to this day.

Recent -. Land clearing activities, trail and cabin constructions have taken place on Anthony Island since it was declared a World Heritage Site.

South Coast, Moresby Island:

1910 - 1948. A whaling station was first constructed at Rose Harbour in July of 1910 by the Queen Charlotte Whaling Company. This station and the Naden Harbour Station were both bought by the Consolidated Whaling Incorporation of Toronto in 1918, which operated the stations until 1943. The venture went bankrupt in 1946, and the properties were purchased from the trustees by Western Whaling. B.C. Packers later bought out all shareholders and sold the machinery not obsolete in 1948. The station has remained inoperative and abandoned ever since.

1913 - . J. Uniaka recorded the *Sakai* mineral claim at Moore Head lying at the southeast entrance point of Houston Stewart Channel. He opened a 50-foot wide open cut near the shoreline and abandoned it shortly after.

1913 - . Mr. J. Uniaka staked the *Copper Coin* claim on the east side of High Island.

1948 - Present. The Canadian Hydrographic Service named Flatrock Island and installed a marine navigational light to mark the entrance to Houston Stewart Channel.

No date. A small cabin was built in recent years on the east shore of Staki Bay within Flamingo Inlet, for the exclusive use of a Fisheries Protection Officer.

No date. Another small cabin for Fisheries Protection Officers was erected on Head Rock within Louscoone Inlet. The tsunami created by the 1964 Alaska earthquake destroyed that cabin. A new one has been built since.

1913 - Present. The Cape St. James navigational and meteorological station was built in 1913 and has been in operation to this day. The Royal Canadian Air Force built and manned a radar station there between 1943 and 1945.

East Coast, Moresby Island:

1862 - . F. Poole established a copper mine on Burnaby Island.

1885 - . F. Poole established and operated a copper mine on Skincuttle Island.

Circa 1900. The *Car* mineral claim was situated inland of Samual Rock. Iron ore was found.

Circa 1900. A mineral claim showing signs of copper and zinc was worked at Raspberry Cove.

1906 - 1913. Several mining claims were staked and worked around Collinson Bay. They were known as the *Meal Ticket*, *Maple Leaf*, *Oceanic*, *Wireless*, and *Thunder* properties. Eventually, the Bellingham Copper Company bought out and consolidated a number of the claims. M.W. Young opened a small store, and built a number of cabins and a float near the head of the bay. By 1909, the C.P.R. made Collinson Bay a regular port of call. A branch telephone line was built to connect Collinson Bay to the Jedway - Ikeda Bay line.

1906 - 1920. The Japanese fisherman, A. Akida, staked the first copper claim near Ikeda Cove. By 1908, the mine had grown enough to employ 118 other Japanese and 2 Europeans. A tramline railway operated between the mine and the wharf. The old sternwheeler Dawson served as bunkhouse, and a small settlement grew. The first wireless station in the Queen Charlotte Islands was erected at the entrance to Ikeda Cove in 1909. The Ikeda Bay Mines were sold to a Vancouver firm in 1910. The company continued to operate until 1920 and then closed. A small and untended graveyard containing the remains of three Japanese miners killed during the early years of the mine operation is situated on the east shore of Ikeda Cove.

1960's. The Jedway Iron Ore Company Ltd. constructed and operated a 360 foot concrete pontoon dock at the end of a rock-filled causeway at Funter Point, on the eastern entrance of Harriet Harbour. A helicopter-landing pad was also constructed near the wharf.

1900 - 1971. A squatter-style settlement of two wharfs, a sawmill, a hotel, a store, and numerous cabin, grew on the west shore of Harriet Harbour. The first townsite of Jedway was formally surveyed by government surveyors on the east shore of Harriet Harbour in 1908, but other than the government mining recorder's office, no lot was ever sold or built on in those times. In 1961, however, the Jedway Iron Ore Company Ltd. constructed a formal townsite there when it opened its open-pit mine operations. This mining venture and the townsite ceased to function in 1971.

1961 -. The owners of Silver Standard Mines applied for the rights to divert Standard Creek, west of Deluge Point, to flow to their claim on the east shore of Harriet Harbour. The mine was later purchased by Jedway Iron Ore Ltd.

1910 - 1930's. Japanese operated an abalone cannery at Jedway Bay (Lizzy Cove) between 1910 and 1913. A saltery was established there prior to 1917, and operated on and off by B. C. Packers until the early 1930's. The grave site of Mrs. Taniyo Isozaki, who died on March 21, 1913, is situated on a small peninsula extending from the east shore into Jedway Bay.

1907 - 1930's. In 1907, F. Watson staked a mining claim near Surprise Creek flowing into North Bay of Huston Inlet. The mining recorder E. M. Sandilands had a trail cut from Huston Inlet to Collison Bay in 1908; Camp Surprise came into being at the shores of North Bay. A saltery and a small abalone cannery operated in the vicinity from the 1920's to the 1930's.

1862 - 1917. F. Poole first developed what is now known as the *Red Raven* mineral claim on East Copper Island in 1862. Reclaimed in 1889 by A. Heino, the claim was worked by him until 1902. He made several copper ore shipments, and then let the claim lapse. A. Johnson took over the claim, only to have Heino take it over again a few years later. Ore shipments were made until 1917. Shafts, open cuts, and tunnels were developed all over the island.

Circa 1862. Remnants of an abandoned house, garden, and well, occur on Jeffrey Island.

1910 - 1912. W. Campbell worked a claim on George Island and made several shipments of high grade copper ore from there.

1862. F. Poole landed on George Island with his party, sunk a 15 foot shaft, and opened several open cuts looking for copper ore, before moving to Burnaby Island where better ore exposures were known to occur.

Circa 1862. F. Poole opened several mine shafts on Bolkus Island.

1862 - 1960's. F. Poole, representing the Queen Charlotte Mining Company of Victoria, opened the first mining shaft and built a log house on Burnaby Island to look for copper deposits. The explorations continued for two years. The project was abandoned in 1864. A small "iron mining boom" occurred between the years 1906 and 1912, but no significant discoveries were made. In the 1960's, the Burnaby Iron Mines Ltd. and the Merrican International Mines Ltd. made newspaper headlines with the former's 47 staked claims of iron ore deposits; while the latter company's main activities were centred around an area about three miles southwest of Scudder Point where a supply road was constructed 1 1/2 miles inland.

1862 - 1864. F. Poole established and operated his main mining camp at Pelican Cove on Burnaby Island. During this period, a number of Skidegate Haidas established a camp at Kingfisher Cove.

1963 -. The *Johnson Nickel* claim in Section Cove on Burnaby Island was extensively prospected by the Jedway Iron Ore Company Ltd., but the mineral potential was found to be localized only.

No date. Ruins of old buildings and pilings of undocumented origin occur at the Dolomite Narrows of Burnaby Strait.

1900 - 1910. A clam cannery was operated intermittently along the north shore of Bag Harbour.

1906 - 1913. Huxley Island became well known during the mining boom of this period, when copper and "free" gold were found on it by "Ross and Abriel". J. M. Carlyle opened and developed the 13 claims of the *Rambler* Group. Surface workings, trails, and cabins were left behind when the venture did not pay off. Signs also remain on the steep hillsides of early logging activities.

1911 - 1912. The Queen Charlotte Pioneer Development Company owned a number of claims in the area of Werner Bay.

1884 -. N. Chittenden observed a stone dam built across the stream at the head of Hutton Inlet. His Haida guide explained the dam to have been a native salmon trap. The same guide made reference to an ancient portage trail from the head of Hutton Inlet up Portage Creek to the west coast of Moresby Island at Gowgaia Bay.

1971 -. The Texas Gulf Sulphur Company established a mineral exploration supply base at Lake Two Fifty-Five (a.k.a. Reg Young Lake) just west of Haswell Bay. Supplies were flown in by float plane from Skidegate.

1878 - 1988. The waters of Hotsprings Island first gained prominence in Dr. Dawson's trip reports. In 1907, F. B. Jones established a mineral claim on the island which he and his son began to work in 1909, while living in a cabin constructed there. They abandoned the claim in 1910. The hot springs became a popular holiday spot during the mining boom years early in the century, and are still used for that purpose. Several other structures and facilities have been added in recent years.

Circa 1913. A small Japanese abalone cannery operated on Murchison Island. The opening and closing dates of this enterprise are not known. A cove on the north shore of the island is now a formal and popular anchorage for small boats.

1910 - 1980's. In 1910, the Moresby Island Lumber Company secured a timber claim at Gate Creek on the east side of Lyell Island. Three logging camps were opened on Lyell Island in the early years of the century by the Kelley Logging Company, the Morgan Logging Company, and the Whalen Pulp & Paper Company; the latter of which occupied a camp on the east shore of Sedgewick Bay in the 1920's. Kelly Logging Company made its headquarters at Atli Inlet, and from there directed operations at Takelley Cove, Powrivco Point and Bay, and Beljay Point and Bay. Whalen Pulp & Paper Company operated a logging camp on the east shore of Beresford Inlet in 1923. Morgan Logging Company developed a similar camp on the west shore of Sedgewick Bay in the 1930's.

The hamlet of Powrivco (the telegraph code for "Powell River Company" which had purchased the Kelley Logging Camp logs) was constructed at the head of Powrivco Bay. The Powell River Company was later purchased by MacMillan-Bloedel Limited. It continued logging on the island into the middle of the 1980's under the auspices of the British Columbia Forestry Service Tree Farm Licence No. 24, Block 3.

Circa 1956. The north shores of Lyell Bay southeast of Topping Islands are the site of the ten registered claims of the *Lobstick* mining property which was seriously explored for its iron deposits by the Falconbridge Mining Company.

1878 - 1901. The bituminous surface outpourings on Tar Islands were seriously surveyed and investigated first by Dr. G. M. Dawson and later by H. Carmichael, provincial assayer for the Department of Mines. The latter also noted and reported on similar outpourings on the shores of Ramsey, House and Agglomerate Islands.

1852 - 1853. Several mining claims were staked and worked on Shuttle Island by C. Mulkley and his two partners. A logging camp operated on the island during the First World War years to extract spruce lumber for aeroplane construction purposes.

No date. The Fisheries Protection Branch has caused formal boat watering facilities to be erected at the head of a small, unnamed cove near the north end of Hoya Passage.

1907 - Present. Prospecting activities in the general area of a small settlement that was to become known as Lockeport, commenced early in this century when E. M. Morgan and his two sons found promising copper ore exposures near Anna Lake. Eventually, several individual and groups of mining claims became activated and worked; i.e, the *Swede* Group, *Montana* Group, *McGuire* Group (*Copper Belle*), *Last Chance*, *Tiger* and*Longfellow* claims, and the *Apex* Mountain Mine. An extensive trail network was constructed between 1907 and 1913, the main trail of which extended from Lockeport along the west side of Anna Inlet to Anna Lake and Apex Mountain to Botany Bay near Tasu on the west side of the island. A spur trail branched off from the head of Anna Inlet to the *Copper Belle* workings. Still another spur did at one time branch off from the latter claims to lead to Crescent Bay and then on to the west side of the island. By 1909, steamships of the Canadian Pacific Railway Company made regular stops at "Locke Harbour". The early mining period was drawing to a close by 1918, when a fish cannery was constructed and operated at Lockeport until about 1928. The hamlet's post office remained open until 1938, at which time Lockeport had become a ghost town. Serious exploratory work was reactivated in 1988 on some of the mining claims at the head of McEchran Cove, while the supporting camp was maintained temporarily at the old Lockeport site.

1908 -. Several claims were established and worked for their copper showings at the head of Crescent Inlet. A trail was cut in the same year to run from the inlet via Flat Creek to Tasu Sound on the west coast of the island.

No date. In addition to the land uses already listed, the Moresby Island, B.C., Map 103 B-C (3rd Edtn.) March 1979, produced by the Ministry of Environment, Province of British Columbia, shows the presence of the following timber licenses: TL 1695, TL 1292 (Lyell Island), TL 1207 (Richardson Island), TL 1701 (Tanu Island), TL 1209 (Tangil Peninsula), TL 1205, TL 1206 (Crescent Inlet). It can be presumed that some land uses were conducted within these timber limits.

The foregoing introduction to and rather pedestrian description of past land uses practiced on South Moresby Island, provides enough of an overview to indicate that while resource exploitation activities were diverse and widespread, their intensities and therefore impacts on the land base, were for the most part focussed on relatively small areas of land. The exceptions, of course, are the massive land alterations associated with the activities of the Jedway iron mine and the timber removal on Lyell Island. It is infinitely more difficult to draw any conclusions about the environmental impacts which fish and abalone canneries, and whaling stations with their relatively small land base, might have had on marine resources; or, for that matter, about the environmental impacts the streams containing mine tailing effluents are imposing on fish habitats and marine stocks in the vicinity of their outlets.

a) RESOURCE ANALYSIS

It is to the full credit of Dalzell (1981, 1988) that the Canadian Parks Service personnel, the most recent arrivals on the South Moresby Island scene, are afforded the first view of the range of exploitative activities that were visited upon the Island since the introduction of European commerce and traders. Most of these activities are known to have ceased on their own accord some years ago, while others were brought to a conclusion by political decisions but a very short while ago. There remains, however, the potential that the exploration for and exploitation of ore and hydrocarbon deposits may continue into the foreseeable future, and thus continue to threaten the environmental integrity of the land base of the South Moresby / Gwaii Haanas National Park Reserve.

A less clear issue of past and present land uses is that of the extent of the effect of human activities in general, on what would otherwise have been the natural evolution of the biotic and abiotic resources of the Islands, and thereby on their synecology. In many an instance, the local natural environment appears to be robust enough to have reclaimed many of the sites of earlier human activities. The Jedway mine activities obviously do not fit within that category. Yet, though new to the area, a knowledgeable observer does obtain glimpses of environmental stresses that are merely hidden under the lush vegetative growth, but reach well beyond the areas that are said to have seen resource uses in the past. One suspects, therefore, that a detailed and concentrated investigation into the extent and effect of past resource uses may very well uncover remnants of additional and theretofore undocumented exploitation activities throughout South Moresby Island.

- Management Concerns

The most obvious management concerns presenting themselves from the foregoing description and discussion are:

(1) In the context of the current National Parks Act, the National Park Policy, and the requirements of the Environmental Assessment & Review Process, what are the implications to resource managers of having inherited so many sites and areas previously impacted by land use and resource extractive activities?

(2) Upon having duly considered the previous question, resource managers must ask themselves the further question of what can be done, or ought to be done, to classify the impacted sites and areas into groupings that ought to be (a) retained as they are, or (b) be developed, in order to achieve specific organizational program goals; as for instance, historical park interpretation and visitor services activities. Furthermore, for any sites or areas falling within these two categories, decisions must be made about which of them can be or need to be scheduled for rehabilitation, and which are too severely impacted to make any rehabilitation efforts economically practicable.

(3) For all known and yet to be discovered sites and areas, it would appear to be essential that further literature and possibly field research must first be conducted in order to gather all of the information and artifacts required to achieve the stated program goals. That may require the integration of local, provincial, and federal human resources, and the work must be conducted with the greatest care so that no data is overlooked.

Finally, it is imperative that resource managers of the Canadian Parks Service consider one or more of the following points:

- *Analyze the existing information base on past and present resource uses within the area of the reserve, for the purpose of improving the general levels of knowledge within the organization about the subject matter, and thereby develop a larger degree of understanding of the extent and effects of past activities; that is, in the social, historical and environmental contexts.*

- *Determine the "value", or lack thereof, of each of the sites or areas previously subjected to resource use and exploitation, to the program objectives of the Canadian Parks Service.*

- *Provide firm assurances that all such sites or areas are provided with a high degree of protection from wanton destruction and pilfering, regardless of their established or inferred value(s), and that their historical stature will be retained within the documented record of and for the park reserve.*

- Status of Knowledge

The current level of knowledge among the Canadian Parks Service personnel of past and present resource use is surmised to be based primarily on recent local contacts, and those historical accounts compiled and published by Kathleen E. Dalzell. To date, no personnel, funding, or time commitments, have been made by the organization to supplement the works of that author.

The current data base is believed to be incomplete, and it is insufficient in scope and detail on which to actually base resource management activities. It is strongly suggested that research be conducted in the near future to confirm the available data, identify and describe new data, and thereby allow the development of a firm management strategy for sites and areas that have previously undergone land uses and resource exploitations.

b) SELECT REFERENCE SOURCES

Anonymous 1983b.
South Moresby: Land Use Alternatives. South Moresby Resource Planning Team, British Columbia Ministry of Forests; The Queen's Printer, Victoria, British Columbia. 249p.

Dalzell, K.E. 1988 (Edtn.).
The Queen Charlotte Islands, Volume 1 : 1774-1966. Bill Ellis, Publisher, Queen Charlotte City, British Columbia. 340p.

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The Queen Charlotte Islands, Volume 2 : Places and Names. Bill Ellis, Publisher, Queen Charlotte City, British Columbia. 472p.

B. MARINE RESOURCE USE

Marine resource extraction in the Queen Charlotte Islands area extends to the earliest advent of humankind. While the mechanisms of resource use have changed over time and the volume of extraction has increased in the case of most resources, the sea has been a vital part of human economy and will no doubt continue to be so. Commercial resource extraction and the introduction of sport fishery are both modern inventions in the region. The occupation of the marine environment for the purpose of mariculture is a relatively new occurrence as well. Petroleum and mineral extraction have only recently been contemplated in the marine environment. While non-depletive in nature, the use of the sea for transportation and recreational purposes is nonetheless a use of the marine environment which has implications for its well-being.

Early resource extraction applied only to the marine flora and fauna. Early cultures practiced subsistent resource extraction. Marine plants have figured prominently in both the diet and the technology of the Haida people.

Amongst food items, giant kelp, *Macrocystis integrifolia*, was and continues to be the favoured marine alga for the spawn-on-kelp delicacy which the Haida know as *gow*, made with spawn of the Pacific herring, *Culpea harengus pallasi* (Turner 1975). Traditionally both eelgrass, *Zostera mariana*, and boa kelp, *Egregia menziesii*, were used as well, but the contemporary harvest relies mainly on artificially maintained pens of giant kelp (Jamieson & Francis 1986). The food is traditionally eaten with a fish grease made from the eulachon, *Thaleichthys pacificus*, though more modern condiments now prevail. Red laver, *Porphyra perforata*, is another marine alga common to the traditional Haida diet (Turner 1975). Sometimes flavoured with the juice of chewed rock chitons (class Polyplacophora), the dish was often accompanied by eulachon grease, boiled chum salmon, *Oncorhynchus keta*, boiled clams of various species, or the heads of Pacific halibut, *Hippoglossus stenolepis*.

The Haida have traditionally employed a number of marine flora in technological applications (Turner 1979). Those used by children in play include the sac alga, *Halosaccium glandiforme*, out of which children would squirt water, and two varieties of brown algae - the convoluted, brain-like alga, *Leathesia difformis*, and sea wrack, *Fucus gardineri*, both of which children were wont to step on to make them pop. Sea wrack as well as other alga such as the distinctly ruffled and perforated red alga, *Porphyra perforata*, were placed on rocks in order to generate steam for cooking, bending and moulding wood, and traditional steambaths. The same sorts of marine alga were often gathered from the sea and placed immediately on fish in boats in order to keep the fish cool. Bull kelp, *Nereocystis lutkeana*, found a number of technological applications in the native Indian culture of the Queen Charlotte Islands: Stalks were dried and spliced for fishing lines, nets, ropes, anchor lines, and harpoon lines. The hollow upper stalks and floats were used to store eulachon grease, fish oil, and water. The stalks were used as well for targets in throwing games.

Numerous marine fauna have been essential to the diet and technology of the Haida people. Most of the more than 255 species of fish thought to inhabit the waters off the Queen Charlotte Islands have been subject to traditional, opportunistic fishing, but the contemporary native food fishery focuses largely on sockeye salmon, *Oncorhynchus nerka*, and chum salmon, *Oncorhynchus keta* (Ireland 1989). Sockeye are harvested with set nets in the spring, and chum are harvested with the use of set nets or commercial gear in the fall. The use of the eulachon as a food source has already been mentioned, but it took on greater importance as a source of fat for barter, the oil of the fish being unique amongst fish oils in that it becomes solid at ordinary temperatures (Hart 1973).

A wide variety of marine invertebrates have traditionally been utilized by the Haida people. Documented knowledge of such usage is sparse. The principal work in the field is by Ellis and Wilson (1981) and is confined to the knowledge and usage of marine invertebrates by the Skidigate Haida.

Marine Invertebrate Usage by the Skidegate Haida People
(after Ellis & Wilson 1981)

Species:	Usage:
Barnacles (incl. *Balanus cariosus*)	Eaten in times of famine or rough seas, and even today if found on a California mussel which has been steamed.
California mussel (*Mytilus californianus*)	Eaten steamed, skewered on sticks, and dried, or roasted before an open fire.
Edible blue mussel (*Mytillus edulis*)	Steamed, roasted before and open fire, or eaten raw.
Goose barnacle (*Pollicipes polymerus*)	Boiled, roasted before an open fire, or sometimes eaten raw.
Black katy chiton (*Katharina tunicata*)	Cooked in the coals of a fire, quickly boiled, or eaten raw.
Giant red chiton (*Cryptochiton stelleri*)	Quickly boiled or pounded and eaten raw.
Butter clam (*Saxidomus giganteus*)	Roasted by an open fire, steamed in a pit, skewered on sticks and dried, or eaten raw.
Native littleneck clam (*Protothaca staminea*)	Eaten raw or (rarely) cooked.
Cockle (*Clinocardium nuttalli*)	Steamed or eaten raw.
Razor clam (*Siliqua patula*)	Roasted by an open fire, steamed in a pit, skewered on a stick and dried, or eaten raw.

Marine Invertebrate Usage by the Skidegate Haida People (cont.)
(after Ellis & Wilson 1981)

Species:	Usage:
Horse clam (*Tresus capax*)	Roasted in hot ashes, cooked on a stick by the fire, skewered on a stick and dried, or boiled and eaten.
Geoduck clam (*Panopea generosa*)	Roasted in hot ashes, cooked on a stick by the fire, skewered on a stick and dried, or boiled and eaten.
Piddock (probably *Zirfaea pilsbryi*)	Roasted by an open fire, steamed in a pit, skewered on sticks and dried, or eaten raw.
Sea star (*Pycnopodia helianthioides*)	Mulched into the soil with sea wrack as fertilizer in potatoe gardens.
Sea cucumber (*Parastichopus californicus*)	Boiled and eaten, or the head bitten off and eaten raw.
Octopus (*Octopus dofleini*)	The beak and gills were eaten raw. The whole animal (eviscerated) was roasted in the ashes of a fire, the head was filled with oil and cooked on a stick beside the fire, or entire octopus was boiled in a cedar box. Legs were used to bandage burns. Dried and later soaked in water, it is the most effective bait for halibut. Today, the octopus is prepared by quick frying in a pan or by simmering in a closed Dutch oven.
Purple hinged rock scallop (*Hinnites giganteus*)	Cooked in their own juices beside a fire or boiled with red laver and eaten. Today, the adductor muscles are fried.
Green sea urchin (*Strongylocentrotus droebachiensis*)	The gonads are eaten raw.
Giant red sea urchin (*Strongylocentrotus franciscanus*)	The gonads are eaten raw.

Marine Invertebrate Usage by the Skidegate Haida People (cont.)
(after Ellis & Wilson 1981)

Species:	Usage:
Purple sea urchin (*Strongylocentrotus purpuratus*)	The gonads are eaten raw.
Northern abalone (*Haliotus kamtschatkana*)	Originally eaten alive. The gonads were eaten raw. Once boiled, smoked and dried, abalone are now commonly pounded and fried.
California abalone (*Haliotis rufescens*)	Though not native, the shells were traded to the Haida of the Queen Charlotte Islands. Pieces of the shell were used as money and as decorative inlay, fixed in place with halibut-tail glue.
Red turban shell (*Astraea gibberosa*)	The opercula were used as decorative inlay, fixed in place with halibut-tail glue.
Green sea anemone (likely *Anthopleura xanthogrammica*)	Skewered on a stick, roasted over a fire and eaten.
Hermit crab (*Pagurus beringanus*)	Collected for the growth of the sponge,Suberites ficus which often grew on its shell. the sponge was dried and used to polish slate.
Dunginess crab (*Cancer magister*)	Formerly steamed in pits, today they are boiled before eating.
Alaska king crab (*Paralithodes camtschatica*)	Formerly steamed in pits, today they are boiled before eating.
Box crab (likely *Lophplithodes mandtii*)	Steamed in pits before eating.
Dentalium (*Dentalium pretiosum*)	Valued as ornaments for dancing gear and neclaces, shells were also traded with other tribes.

The exploitation of the marine and marine-related mammalian resource is a historic resource use within Canadian Pacific coastal waters. Depletions of certain of the cetacean stocks and the virtual extirpation of the sea otter population are both consequences of that exploitation.

The harvest of the marine floral resource on a commercial scale has not been successful in the Queen Charlotte Islands (Coon *et al.* 1980; Anon. 1980). Attempts to build kelp meal processing plants in the area have failed. There is some impact on the giant kelp population through the herring spawn-on-kelp fishery. As of August 1987, there were 28 row-on-kelp (*gow*) fishery permits issued for the whole of the British Columbia Coast, of which 14 were for the Queen Charlotte Islands (Searing 1987). About 80 percent of the fishing is done in the Burnaby Island area, within the proposed national marine park reserve boundary.

The four-year average catch in the sport fishery for the Queen Charlotte Islands over the period 1980-1983 was 8,890 Coho salmon, *Oncorhynchus kisutch*, and 780 Chinook salmon, *O. tshawytscha* (Anon. 1986b). Sport fishing does not at present generate substantial income or employment in the Queen Charlotte Islands, but it is important to some businesses, and does form a part of the lifestyle of the residents (Ireland 1989). The recreational fishery is confined to the sheltered, nearshore waters of the Queen Charlotte Islands and includes a number of the salmon, groundfish and shellfish, amongst them: chinook salmon, coho salmon, pink salmon, chum salmon, sockeye salmon, steelhead, trout lingcod, rockfish, Pacific cod, halibut, herring, Dungeness crab, prawn, shrimp, abalone, octopus, butter clam, littleneck clam, razor clam, mussel, scallop and oyster (Anon. 1985a).

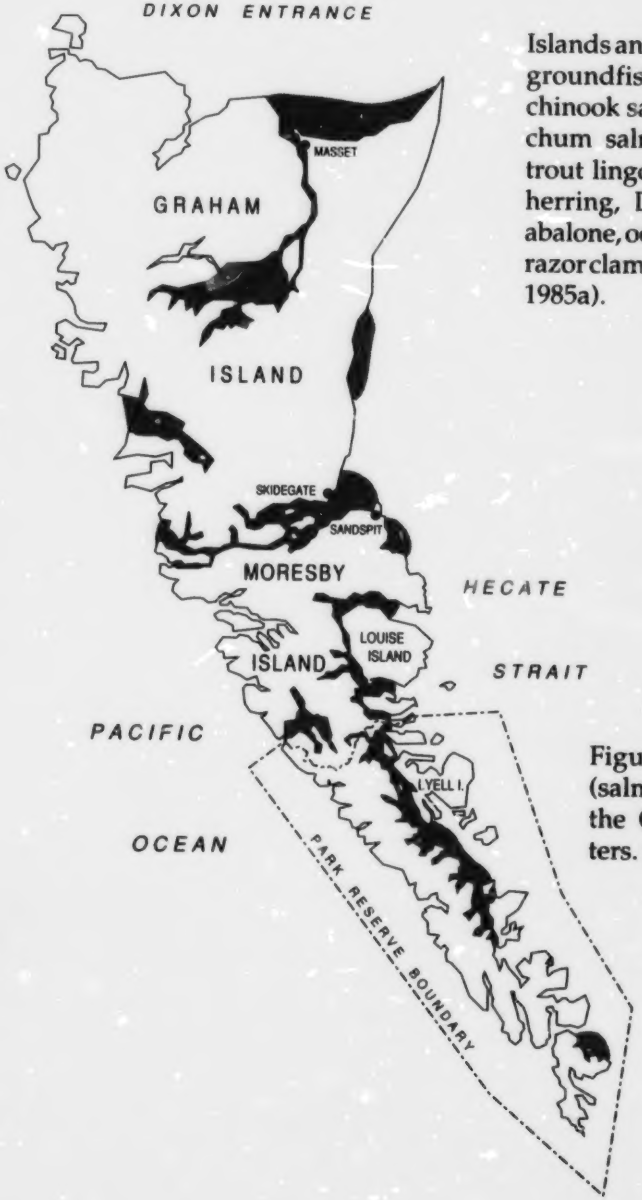
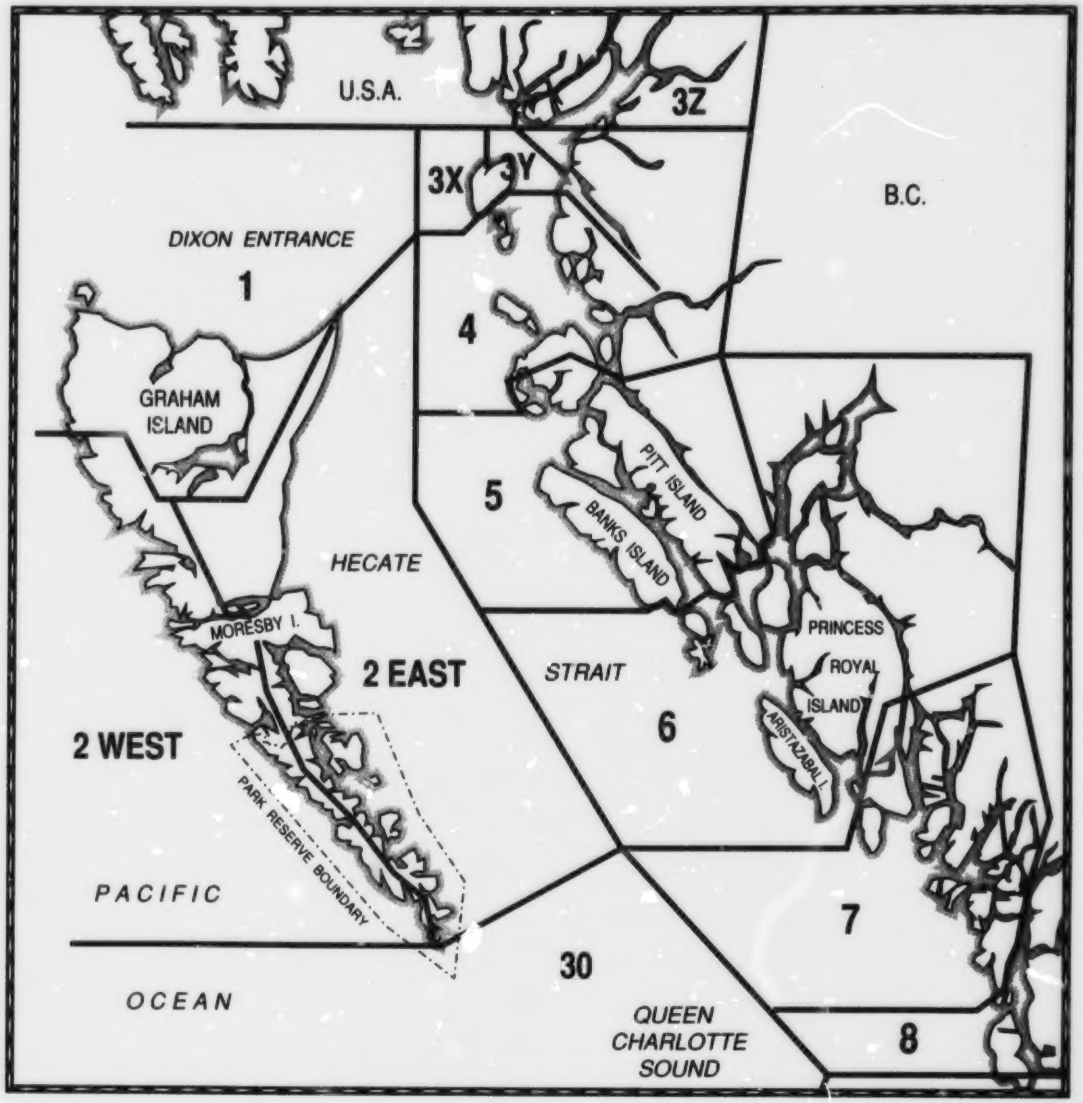


Figure 177. Recreational fishery (salmon, groundfish, shellfish) in the Queen Charlotte Islands waters. (after Anon. 1985a)

The commercial fishing industry is a major economic force in the Queen Charlotte Islands in terms of employment. Likewise, the impact on the natural resource base is important. The commercial fishery exploits the whole gamut of fisheries resources, from ground fish and invertebrates, to anadromous and pelagic species. For statistical purposes, fishing waters off the Queen Charlotte Islands are considered to be Dixon Entrance, Hecate Strait and waters off the west coast. Those waters are encompassed in Department of Fisheries and Oceans Statistical Areas 1, 2 West and 2 East.


U.S.A.
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3X
3Y
B.C.
DIXON ENTRANCE
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GRAHAM ISLAND
PITT ISLAND
5
BANKS ISLAND
HECATE
MORESBY I.
PRINCESS ROYAL ISLAND
2 EAST
STRAIT
ARISTAZABAL I.
6
2 WEST
PARK RESERVE BOUNDARY
PACIFIC
7
30
OCEAN
QUEEN CHARLOTTE SOUND
8

Figure 178. Canada Department of Fisheries and Oceans fisheries operations. Statistical areas for northern British Columbia. (after Anon. 1982b)

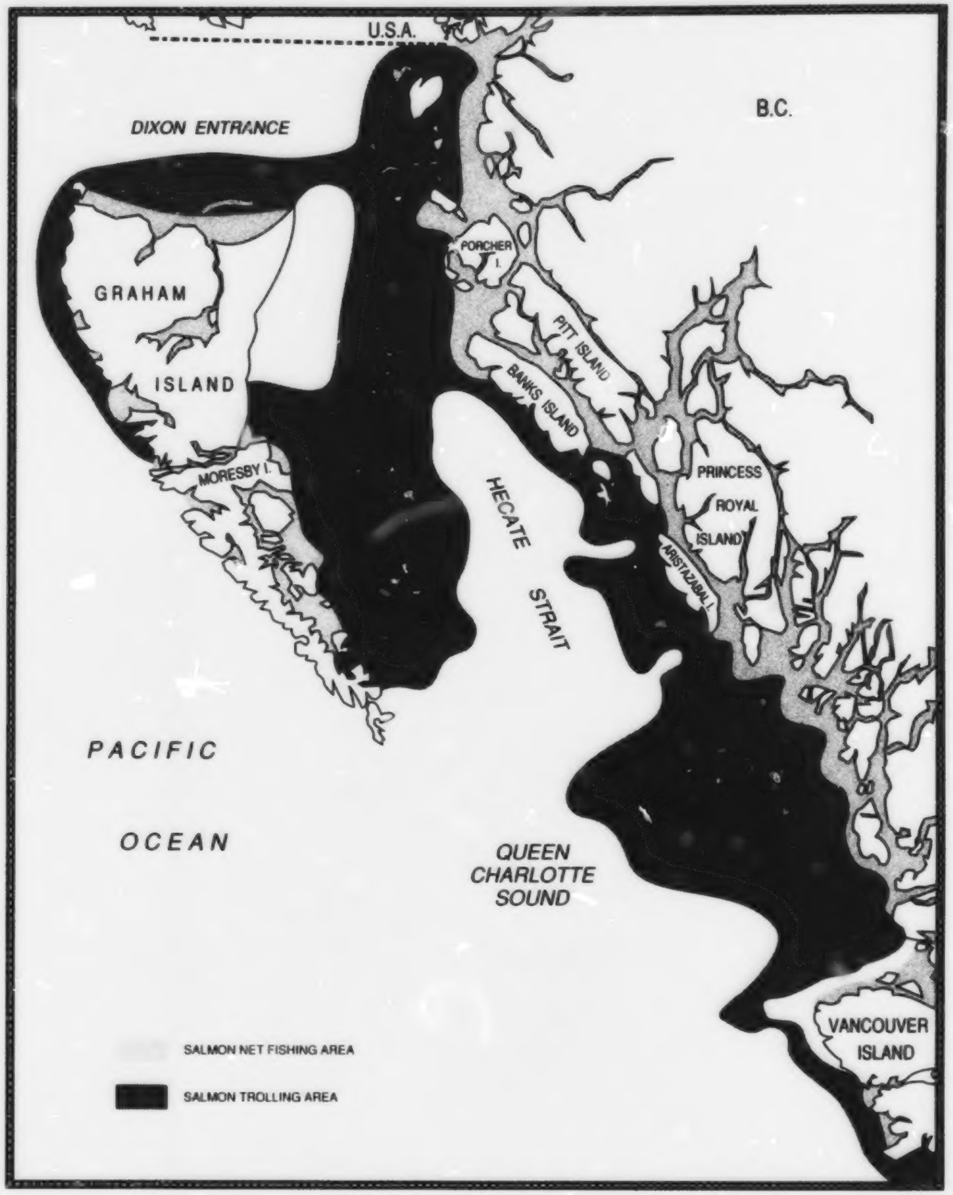
Typically, the annual catch in the offshore waters of the Queen Charlotte Islands (Department of Fisheries and Oceans Statistical Areas 1 and 2) of herring, halibut, cod, sole, rockfish, abalone, crab and geoducks will make up more than 10 percent of the total catch for British Columbian waters (Ireland 1989). Only a small part of that local catch is made by fishermen residing in the Queen Charlotte Islands; for 1979, the catch by vessels based in the Queen Charlotte Islands was only 6 percent of the total catch in waters off the Queen Charlotte Islands.

In the case of the salmon fishery, trollers operate at depths of 50 to 150 metres, so their local area of operation takes in most of Hecate Strait, all of Dixon Entrance and the nearshore waters off the west coast of Graham Island. Net fishing, on the other hand, occurs in the shallower and more protected inshore waters amongst the Queen Charlotte Islands (Anon. 1983a).

Total Metric Tonnes of Fisheries Catch in Statistical Areas 1, 2 West and 2 East, 1976-1980 Average Plus 1981 and 1982 (after Ireland 1989)

Species:	1976-80 QCI Average:	1981 QCI:	1982 QCI:	1982 catch % of B.C. total:
Chinook	900	1,137	1,262	17.8
Sockeye	742	735	271	0.9
Coho	935	893	867	9.3
Pink	1.356	1,347	155	3.9
Other	523	293	437	2.9
Total Salmonids	4,456	4,405	2,992	4.6
Herring	10,571	7,021	5,582	19.4
Other Pelagic Spec.	9	3	-	-
Pacific Halibut	1,586	1,382	1,072	63.4
Pacific Cod	1,068	955	626	13.4
Sole	907	693	662	22.9
Rockfish	2.898	2,915	1,265	12.2
Sablefish	390	1,266	1,748	44.7
Other	1,028	1,859	3,189	56.3
Total Groundfish	7,877	9,070	8.562	27.3
Shellfish	706	671	704	11.2
Total All Species	23,619	21,170	17,840	13.3

The groundfish fishery takes place throughout the Continental shelf area, outside the inshore waters of the Queen Charlotte Islands, including Dixon Entrance, Hecate Strait, Queen Charlotte Sound and the shelf waters off the west coast (Anon. 1985c,d).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GRAHAM
ISLAND
MORESBY I.
PORCHER I.
PITT ISLAND
BANKS ISLAND
HECATE STRAIT
PRINCESS
ROYAL
ISLAND
ARISTAZABAL I.
PACIFIC
OCEAN
QUEEN
CHARLOTTE
SOUND
VANCOUVER
ISLAND
SALMON NET FISHING AREA
SALMON TROLLING AREA

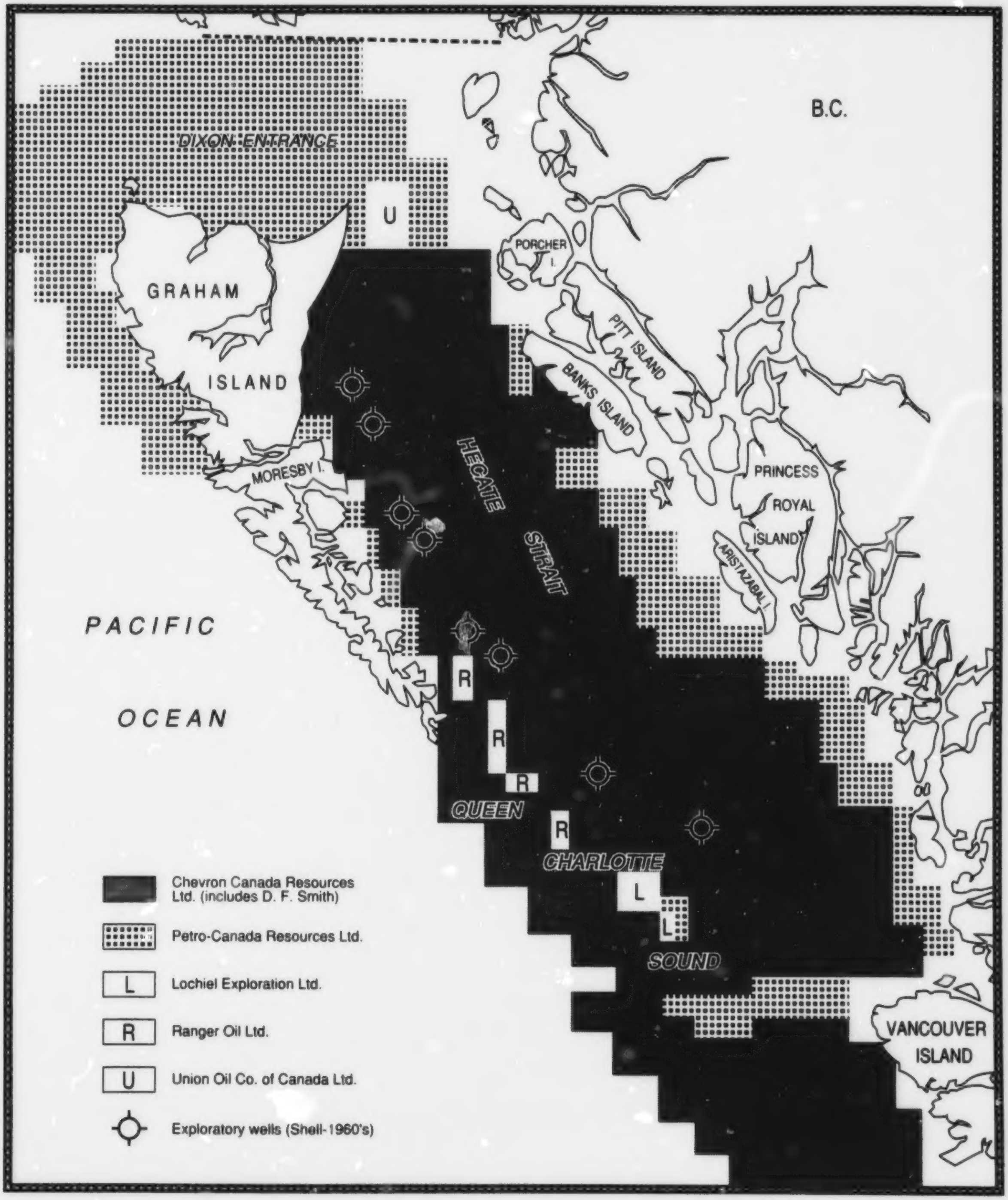
Figure 179. Commercial salmon fishing areas of the Queen Charlotte Island waters. (after Anon. 1978j)

Only in recent years has the extraction of geological resources been contemplated within the marine environment of the Queen Charlotte Islands, and that is limited to the exploration for petroleum. Exploration for oil and gas within the Tertiary Queen Charlotte Basin dates back to 1958 when the Richfield Oil Corporation undertook to drill six exploratory wells by the summer of 1961 without significant showings of oil or gas (Anon. 1982). Shell Canada began acquiring exploration permits in 1961 and had acquired 3.5 million hectares in Hecate Strait and Queen Charlotte Sound by 1968. Their eight wells drilled by May of 1969 showed no significant hydrocarbon accumulations, though several small showings were encountered (Anon 1982). Present marine rights to hydrocarbon exploration in the vicinity of the Queen Charlotte Islands belong mainly to Chevron Canada Resources Ltd. and Petro-Canada Resources Ltd. (Anon 1986c).

The proposals by Chevron Canada Resources Ltd. and Petro-Canada Resources Ltd. to renew hydrocarbon exploration and development activities in Dixon Entrance, Hecate Strait, Queen Charlotte Sound and the waters above the Continental shelf to the west of the Queen Charlotte Islands (Anon. 1982; Anon. 1983a) led the governments of Canada and British Columbia to set up a joint environmental review of the proposals in 1983, the result of which has been to renew the 1972 moratorium on further hydrocarbon exploration and development in the area (Anon. 1986c). Nonetheless, a recent report by the Canada Oil and Gas Lands Administration on the petroleum resource potential within the proposed marine park reserve points out moderate to high petroleum potential offshore of Louise, Lyall and Ramsay Islands (Dietrich *et al.* 1989).

The use of the marine environment as a transportation corridor is a non-extractive use of the marine resource which has been popular since the arrival of the Haida. The usage expanded with the European encounter, and the coast is widely travelled today both by commercial traffic and private boats. Localized congestion may occur during the fishing season, and ports can fill to near capacity, but the marine environment as a transportation corridor is by no means heavily travelled. A measure of the weight of marine traffic is the proximity of the nearest base of the Canadian Coast Guard, which is only as close as Prince Rupert. The three ports in the Queen Charlotte Islands are restrictive to use due to their sizes and depths (Anon. 1983a). The approaches to Masset harbour are as shallow as 4.8 metres. Skidegate Channel is centrally located, but Skidegate harbour offers few facilities and little protection. The wharf facilities at Queen Charlotte City are small. Hecate Strait is plied by tankers, ferries, log booms, barges, fishing vessels and other commercial traffic.

While not extractive in nature, marine tourism and recreation is another important and burgeoning natural resource use which is quite contemporary. The tourist potential of the Queen Charlotte Islands is as yet underrealized (Anon. 1983a). Recreational activity is largely marine-oriented. The pleasure boating population of the Queen Charlotte Islands, for boats over 4.26 m (14 feet), is forecast to have increased from a 1971 level of 1.335 boats to a 1990 level of 3,302 (Anon. 1975).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DIXON ENTRANCE
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PACIFIC
OCEAN
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QUEEN
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CHARLOTTE
L
L
SOUND
VANCOUVER
ISLAND
Chevron Canada Resources Ltd. (includes D. F. Smith)
Petro-Canada Resources Ltd.
L Lochiel Exploration Ltd.
R Ranger Oil Ltd.
U Union Oil Co. of Canada Ltd.
Exploratory wells (Shell-1960's)

Figure 180. Hydrocarbon exploration licences (after Anon. 1986c)

a) RESOURCE ANALYSIS

Traditionally, the marine environment of the Queen Charlotte Islands has provided a largesse of food and an expansive waterway for the native peoples. The subsistent nature of the historical resource use is not known to have left a lasting impact on the marine resource. The fishery is important both culturally and as a means of support to the Haida people.

In the case of the commercial salmon fishery, the contribution of the resource base from the waters surrounding the Queen Charlotte Islands is significant in terms of the catch for all of British Columbia. Other fisheries are less important in terms of their relative contribution to the British Columbia economy, but they provide an important source of livelihood for people in the Queen Charlotte Islands.

While sport fishing plays an important role in the lifestyle of the local residents, it does not generate substantial income in the Queen Charlotte Islands at this point in time. It is expected, however, to have an important future role to play in the provision of a recreational experience to tourists.

Both transportation and recreational usage of the marine environment is little developed in the Queen Charlotte Islands. The potential for tourism development in the Queen Charlotte Islands is largely unrealized.

There is at present a moratorium on hydrocarbon exploration and development in British Columbian coastal waters. To date no explorations have provided positive evidence of significant hydrocarbon reserves.

- Management Concerns

Traditional marine resource extraction by the native people of the Queen Charlotte Islands is little cause for concern. Historical extractive methods and levels of resource use are such that the marine ecosystem can withstand the impact without lasting detriment. The commitment of the Haida to resource conservation is well recognized and respected. However, the level of resource extraction practiced by the native people is not well documented (Anon. 1983a).

The challenge in encourging increased tourism and recreation in the marine environment will be to see that the concept of conservation is properly impressed upon the visitor. Anchor damage to marine life, careless trampling of intertidal communities, illegal souvenir collecting, harassment of marine life above and below the sea surface, and marine pollution are all consequences of increased recreational traffic which can be mitigated with proper public education and control. The National Marine Park Policy vests control over marine transportation in the Ministry of Transport (1986d). Their mandate is to manage marine transportation so that it proceeds in a safe and legal manner.

Both commercial and sport fishery takes place at present within the waters of the proposed reserve. Statistics do not exist for the levels of catch specifically within the proposed reserve. The National Marine Park Policy vests jurisdiction over the natural marine resources in the Department of Fisheries and Oceans (1986d). Their mandate is to manage marine resources in order to maximize the fishery resource.

- Status of Knowledge

The extent of the native food fishery is poorly known. While statistics exist for the commercial and sport fisheries, those statistics are not specific to the proposed park reserve. What data is available is more reliable for fish species caught than it is for shellfish caught. There is a need to work closely with the managers of the fishery resource, the Department of Fisheries and Oceans, to collect more specific data on the present level and extent of resource extraction.

In the absence of an industrial effort to harvest the marine floral resource, there is no effort expended to monitor its casual extraction.

Little has been done on the Queen Charlotte Islands with respect to the potential for the development of recreational opportunities and tourism. Marine traffic patterns also remain unstudied.

Knowledge of the hydrocarbon potential predates the establishment of the 1972 moratorium on hydrocarbon exploration and development. There is as yet no sure indication of economically viable hydrocarbon reserves. The presence of high (greater than 5 percent) concentrations of amphibole, ilmenite and sphene in the heavy mineralogy of the inner British Columbia Continental shelf, from Queen Charlotte Sound to Hecate Strait, has been documented by Barrie et al. *(1988) following on earlier work by Luternauer & Murray (1983), but extraction has not been initiated.*

b) SELECT REFERENCE SOURCES

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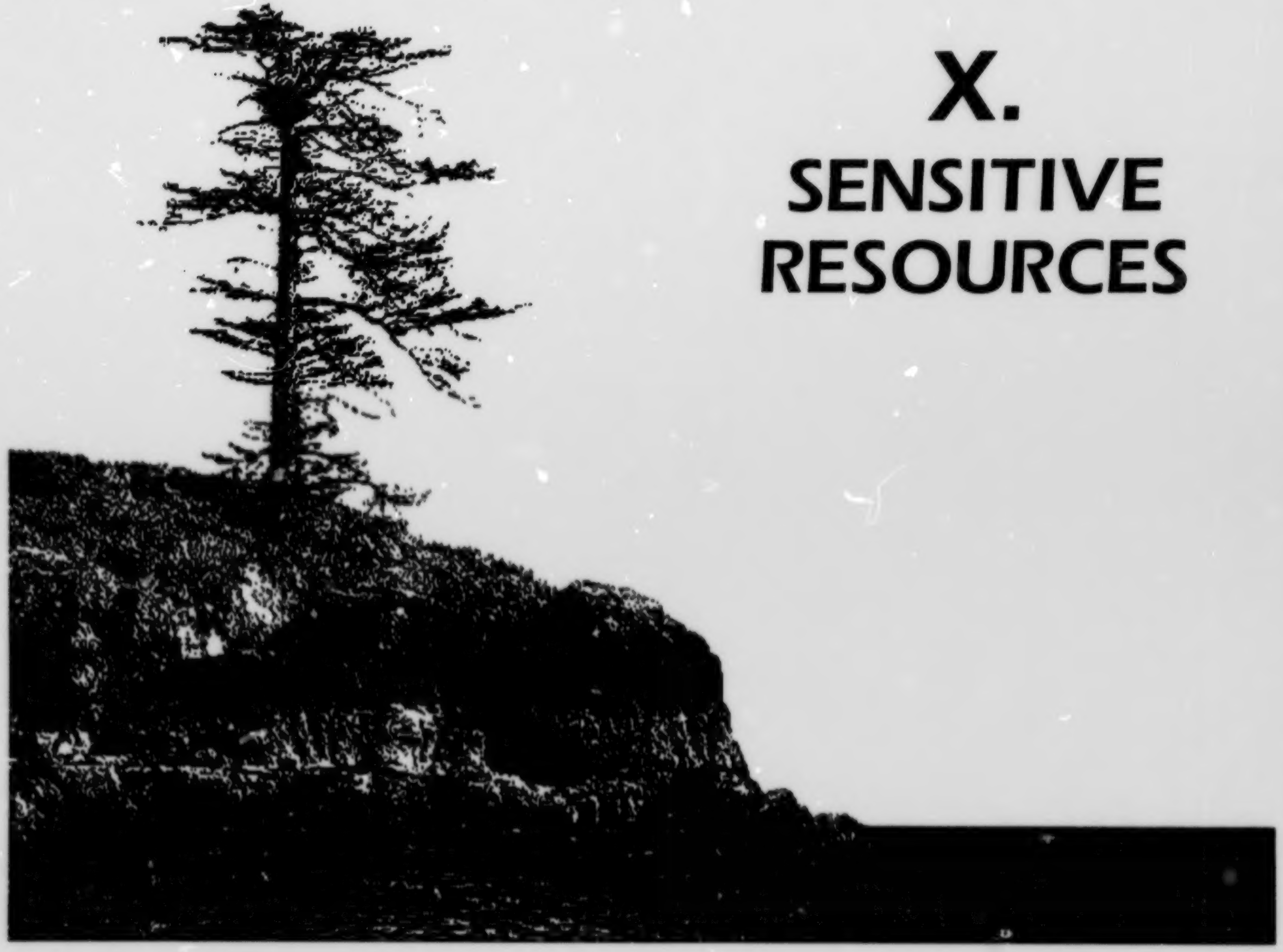
X.

SENSITIVE RESOURCES



SENSITIVE RESOURCES

General Overview

Within the context of the Canadian national parks system, the South Moresby / Gwaii Haanas National Park Reserve is the primary representative example of the northwestern portion of this country's Natural Region 1 (Anon. 1975). Its outstanding natural attributes serve to present the park reserve as one of the last and almost untouched wilderness areas of the northern island environments off the coast of British Columbia.

As the latest addition to the Canadian national park system, it is another of the very special areas in Canada over which the National Parks Act and the National Parks Policy will have jurisdiction. It is now also an area where, in keeping with the dedication clause for the national parks, use and development must be weighed against the mandate of the organization for preservation and protection. In order to achieve that goal, the highly visible and ecologically sensitive natural resources must first be clearly identified, and then weighed according to their individual value and importance, as far as that is possible, through the use of artificial and subjective rating scales.

Luna B. Leopold (1969) and M. Miernik (1974) first pioneered the quantification of landscape aesthetics, and provided subsequent workers with field-tested methodologies to environmentally assess river valleys. Because their approaches were in themselves very similar, and were also found to be generally applicable to the purposes of evaluating the special natural resources within a national park, their methodologies were modified to serve the broader terrestrial and marine considerations required to be addressed hereunder.

Following is an outline of the modified "Resource Value Quantification Scale" scheme developed and utilized to evaluate select park features, sites, or areas, against four paired sets of terms which describe distinct park management planning values that express certain aspects of the national park mandate. Once evaluated, the resulting numerical data were summarized, and a "Total Park Value Scale" was developed from them.

Explanation of the Paired Sets of Terms:

1. UNIQUENESS & RARITY

• **UNIQUE** = Unmatched; unequalled; having no like, or equal, or parallel (Concise Oxford Dictionary, 1964); the term may also be used to describe resources that are truly exceptional within the national park system.

Value Ratings :

Low =
one thereof, in several parks throughout the park system;
Medium =
one thereof, but in several areas of the park;
High =
one thereof, in only one area of the park.

• **RARITY** = Uncommon thing (Concise Oxford Dictionary, 1964). Rarity may be considered in two ways: one refers to resources found only in one park, the other refers to resources found throughout the national park system.

Value Ratings :

Common =
resources that occur frequently and are an obvious part of the landscape; *e.g.*, wooded hillsides, black-tailed deer;
Less Common =
resources that occur less frequently, but are still readily found in the park; *e.g.*, estuaries, black bears;
Rare =
resources of which there are few examples in the park and in the entire national park system.

2. FRAGILITY & REPRESENTATIVENESS

• **FRAGILITY** = Easily snapped or shattered, weak, perishable, of delicate frame (Concise Oxford Dictionary, 1964). It is a term that can be thought of as the relative degree of susceptibility of a resource to change caused by imposed impacts.

Value Ratings :

Low =
the resource can withstand daily human impact with few changes to the environment;
Medium =
the resource can withstand daily human impact, but changes will be caused to the environment;
High =
the resource will be seriously changed or destroyed by daily human impact.

• **REPRESENTATIVENESS** = a primarily physical condition of a resource that is typical for and representative of the natural- or physiographic region in which it occurs.

Value Ratings :

Low =
0 - 50 percent representivity;
Medium =
50 - 70 percent representivity;
High =
75 - 100 percent representivity.

3. SCIENTIFIC & ECOLOGICAL IMPORTANCE

• **SCIENTIFIC IMPORTANCE** = a resource that has attracted, or might attract, the interest of scientists and is a resource that warrants continued scientific monitoring.

Value Ratings :

Low =
the study of a resource appears to have marginal potential to add to man's knowledge;
Medium =
a reasonable potential exists that the study of a resource will increase man's knowledge;
High =
the scientific importance of a resource has already been established; or , the potential is high for the study of a resource to increase man's knowledge considerably.

• **ECOLOGICAL IMPORTANCE** = a resource that sustains an ecological process, or processes; a resource that is an ecological benchmark.

Value Ratings :

Low =
a resource which, if substantially altered, would undergo only minor disruption of its geological or hydrological features; or , of the ecological integrity of the native flora and fauna;
Medium =
A resource which, if substantially altered, would undergo considerable disruption of its geological or hydrological features; or , of the ecological integrity of the native flora and fauna;
High =
A resource which, if substantially altered, would undergo serious disruption or elimination of its geological or hydrological features; or , of the ecological integrity of the native flora and fauna; such a resource is critical to the survival of a species, community, habitat, etc.

A. SENSITIVE TERRESTRIAL RESOURCES

The results of the application of Leopold's modified landscape quantification methodology to select natural resources of the South Moresby / Gwaii Haanas National Park Reserve, are shown in detail under the following tabulations. It must, however, be made clear that the entire effort is at this time based on no more than a first approximation of natural resources selected from available publications. Most of the features, sites, and areas selected have not been visited, studied, or properly evaluated to date for their quality. The following, preliminary listing of natural resources must therefore be seen as an incomplete but dynamic product that will be adjusted as our present levels of knowledge and understanding grow in due course with more research. Furthermore, the arbitrary decision was made at this time not to include any archaeological features, sites, or areas, until the members of the Historical & Archaeological Research Division, Western Region, Canadian Parks Service, have completed their initial investigation and documentation of all heritage resources within this new national park reserve.

4. VISIBILITY & AESTHETIC VALUE

- **VISIBILITY** = the degree of ease by which a resource can be seen or reached by park visitors.

Value Ratings :
Low =
a resource can only be seen or reached with great difficulty; remote sensing is the primary method for park visitors to experience the resource;
Medium =
a resource which can be seen or reached with moderate effort;
High =
a resource which is easily seen, or no effort is required to reach it.

- **AESTHETIC VALUE** = the inherent quality of a resource to elicit a positive emotional response from park visitors in terms of appreciation of its beauty, tranquility, solitude, restlessness (water), etc.

Value Ratings :
Low =
a resource that exhibits only a marginal degree of aesthetic quality;
Medium =
a resource that exhibits a moderate degree or seasonal display of aesthetic quality;
High =
a resource that exhibits a high degree of aesthetic quality, and is outstanding in meeting that aspect of the national park mandate.

Note:
The reciprocals of all value ratings; *i.e.*, 1 or Unity divided by each value rating number, were added to obtain a calculated total sum for each of the resources so treated. Therefore, the lower the calculated total sum of a resource, the higher its prioty rating.

Sensitive Terrestrial Features

No.	Natural Feature :	Park Reserve Locality :	Resource :
1	Queen Charlotte Fault	Offshore, Continental Slope	Geological
2	San Christoval Range	Queen Charlotte Mountains	Aesthetic
3	Puffin Cove	West Coast, Moresby Island	Miscellaneous
4	Louscoone Inlet Fault	West Coast, Moresby Island	Geological
5	Ninstints	Anthony Island	Heritage
6	Milk Quartz Outcrops	Anthony Island	Geological
7	Pillow Lava Outcrops	Gordon Island	Geological
8	Fossil Occurrences	Luxana Bay, Kunghit Island	Palaeontological
9	Rose Harbour	Kunghit Island	Miscellaneous
10	Fossil Occurrences	Hornby Pt., Kunghit Island	Palaeontological
11	Mud Flats	Sedmond Creek, Moresby Isl.	Ornithological
12	Fossil Occurrences	Sedmond Creek, Moresby Isl.	Palaeontological
13	Fossil Occurrences	Ross Island	Palaeontological
14	Fossil Occurrences	Point Langford, Moresby Island	Palaeontological
15	Fossil Occurrences	South Cove, Moresby Island	Palaeontological
16	Fossil Occurrences	Iron Point, Moresby Island	Palaeontological
17	Grave Sites	Ikeda Cove, Moresby Island	Cultural
18	Jedway Townsite	Harriet Harbour, Moresby Island	Miscellaneous
19	Jedway Mine	Moresby Island	Miscellaneous
20	Rennell Sound Fault	Moresby Island	Geological
21	Dolomite Narrows	Moresby/Burnaby Islands	Biological
22	Fossil Occurrences	Funter Point, Moresby Island	Palaeontological
23	Fossil Occurrences	Swan Island	Palaeontological
24	Fossil Occurrences	Poole Inlet, Burnaby Island	Palaeontological
25	Grotto Landform	Poole Point, Burnaby Island	Miscellaneous
26	Eagle Eyries	Burnaby Island	Ornithological
27	Fossil Occurrences	Pelican Cove, Burnaby Island	Palaeontological
28	Fossil Occurrences	Huxley Island	Palaeontological
29	Fossil Occurrences	Arichika Island	Palaeontological
30	Earthquake Epicentre	Werner Bay/Hutton Inlet	Geological
31	Eagle Eyries	Ramsey Island	Ornithological
32	Geothermal Springs	Hotsprings Island	Miscellaneous
33	Geothermal Meadow	Hotsprings Island	Miscellaneous
34	Rock Ledges	Faraday Island	Biological
35	Logging Activities	Lyell Island	Ecological
36	Eagle Eyries	Lyell Island	Ornithological
37	Eagle Eyries	Richardson Island	Ornithological
38	Fossil Occurrences	Gil Islet	Palaeontological
39	Lockeport Townsite	Moresby Island	Miscellaneous
40	Eagle Eyries	Tanu Island	Ornithological
41	Eagle Eyries	Kunga Island	Ornithological
42	Fossil Occurrences	Kunga Island	Palaeontological
43	Flower Pot Island	Logan Inlet	Miscellaneous
44	Peregrine Falcon Nests	Lost Island	Ornithological

It must also be pointed out that where the rating of the perceived resource value could not be ascertained with some reasonable certainty, mainly due to the lack of specific information, lack of familiarity with the park reserve, or lack of knowledge, the number 5 was assigned arbitrarily as a medium value, until such a time as a more informed evaluation can be conducted.

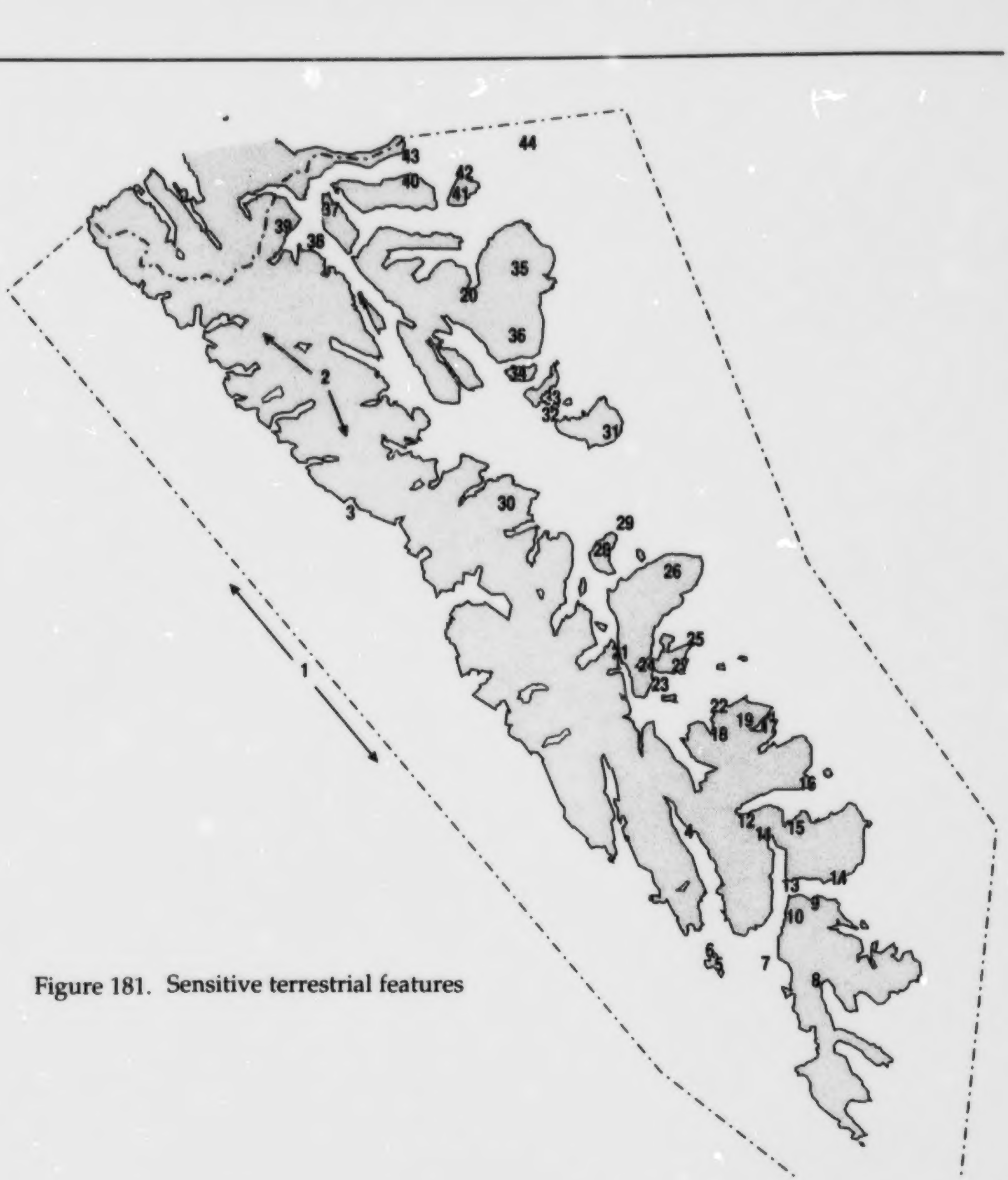

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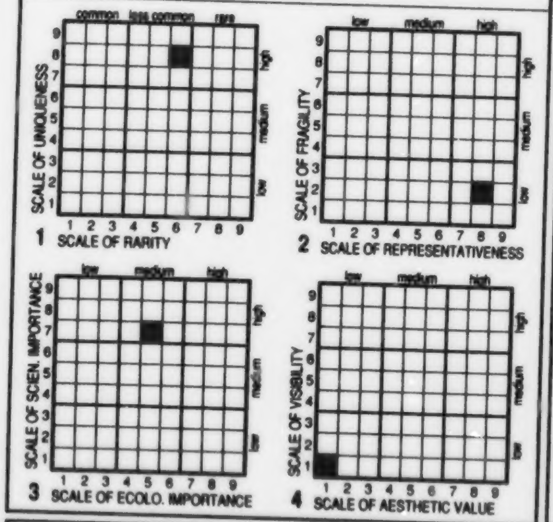
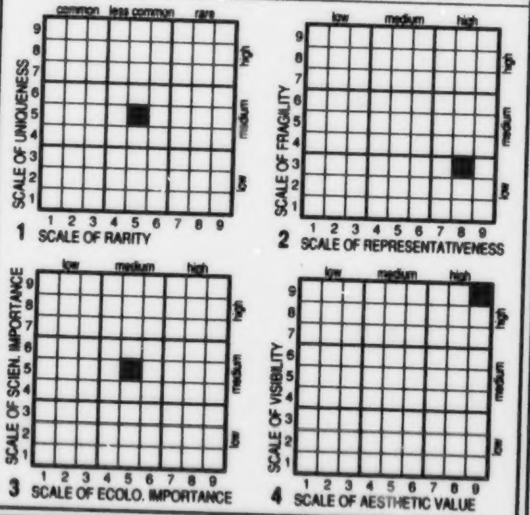
Figure 181. Sensitive terrestrial features

TERRESTRIAL RESOURCE VALUE QUANTIFICATION SCALES

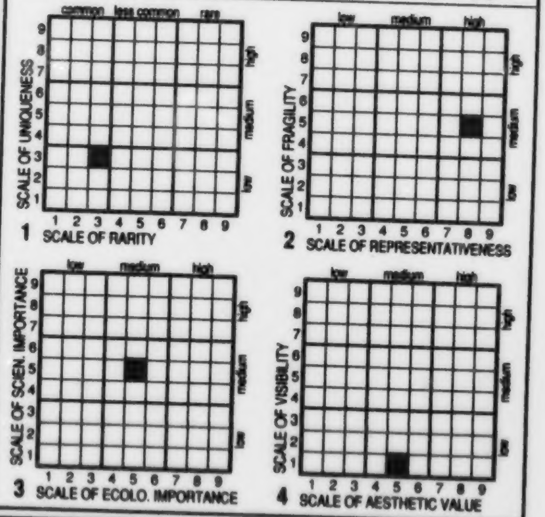
QUEEN CHARLOTTE FAULT #1



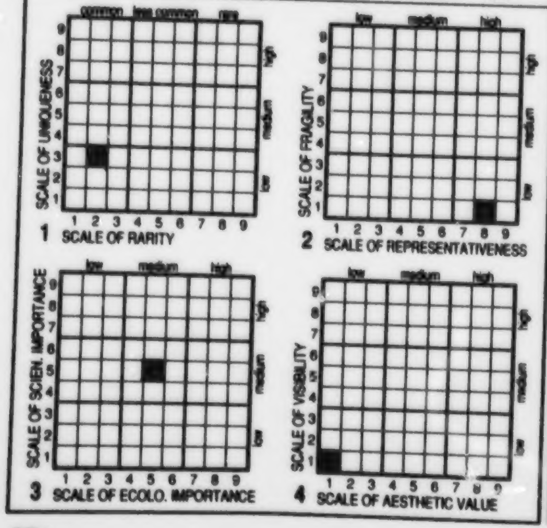
SAN CHRISTOVAL RANGE
QUEEN CHARLOTTE MTS. #2



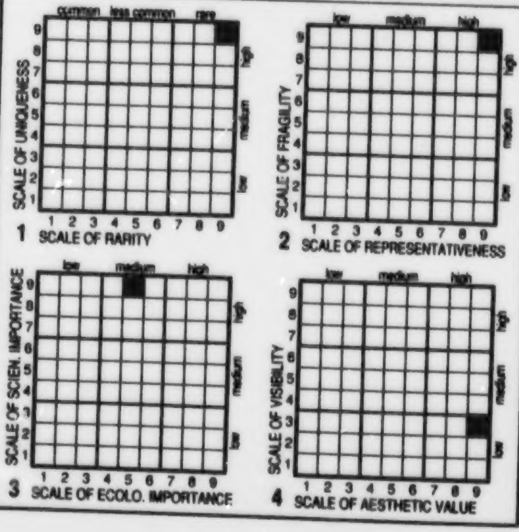
PUFFIN COVE
WEST COAST, MORESBY ISLAND #3



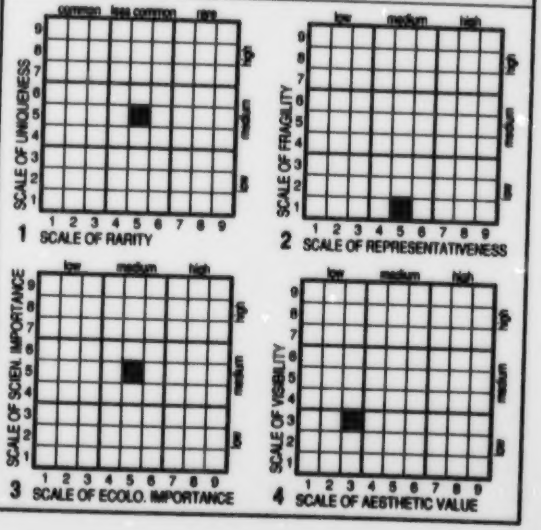
LOUSCOONE INLET FAULT
WEST COAST, MORESBY ISLAND #4



NINSTINTS (WORLD HERITAGE SITE)
ANTHONY ISLAND #5

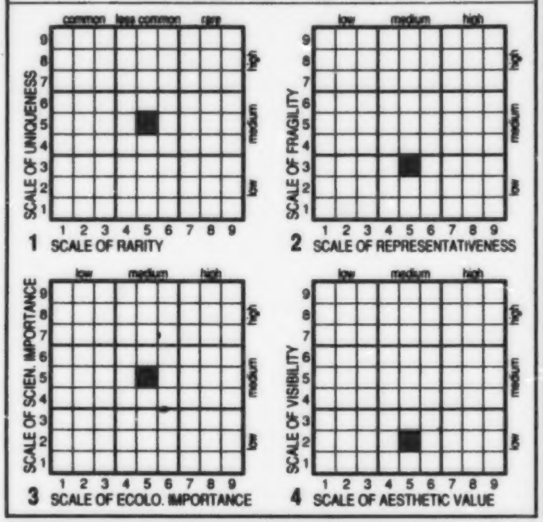


MILK QUARTZ OUTCROPS
ANTHONY ISLAND #6

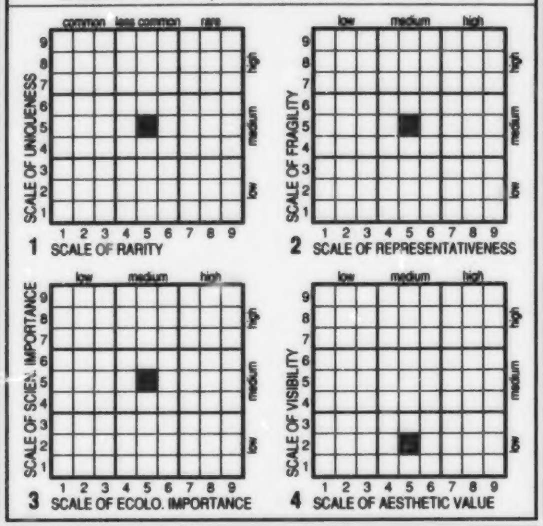


TERRESTRIAL RESOURCE VALUE QUANTIFICATION SCALES

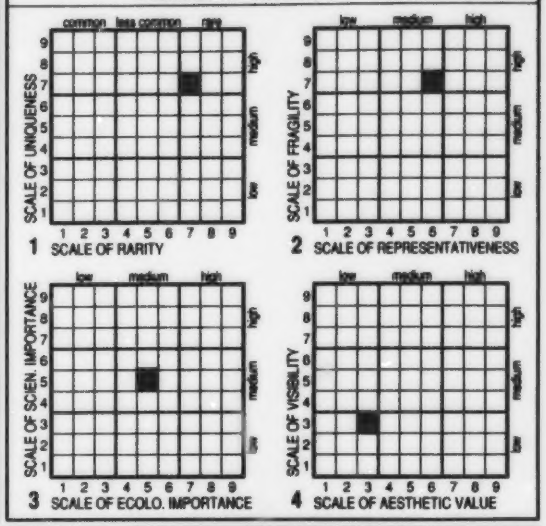
PILLOW LAVA BASALT OUTCROPS
GORDON ISLAND #7



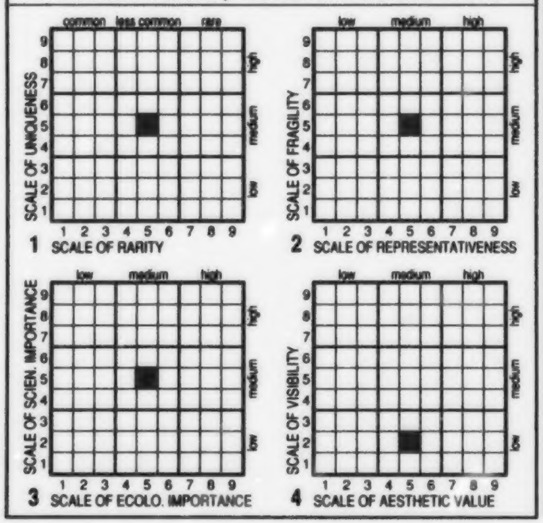
FOSSILS
LUZANA BAY, KUNGHIT ISLAND #8



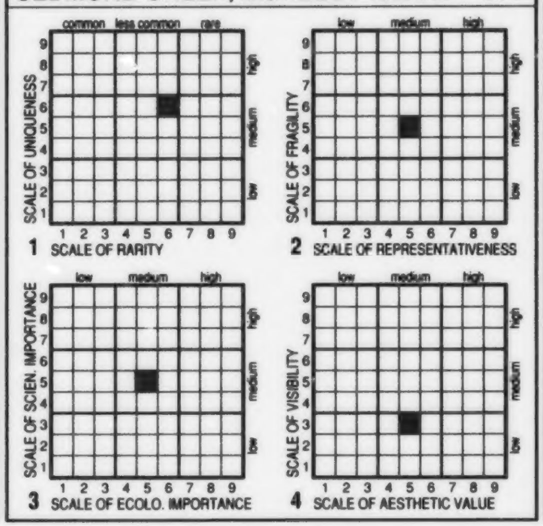
ROSE HARBOUR
KUNGHIT ISLAND #9



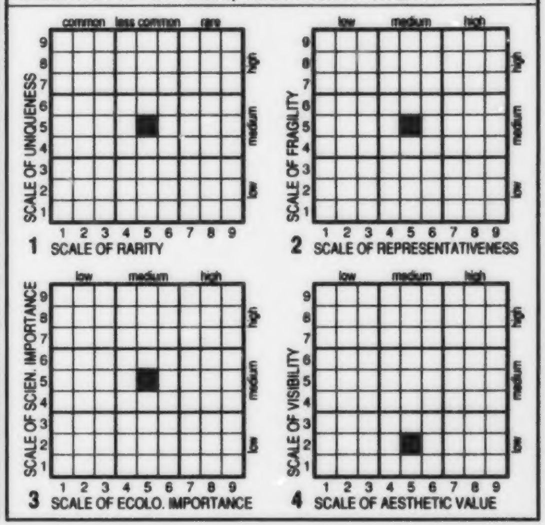
FOSSILS - 5 KM SOUTH OF
HORNBY POINT, KUNGHIT ISLAND #10



MUD FLATS (DUCKS AND GEESE)
SEDMOND CREEK, MORESBY ISLAND #11

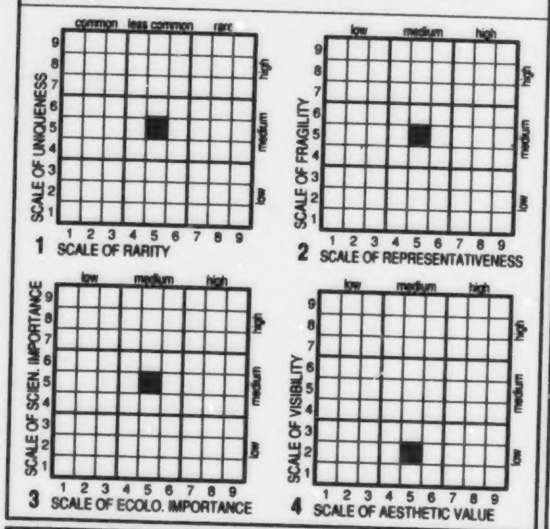


FOSSILS - SOUTH OF
SEDMOND CREEK, MORESBY ISLAND #12

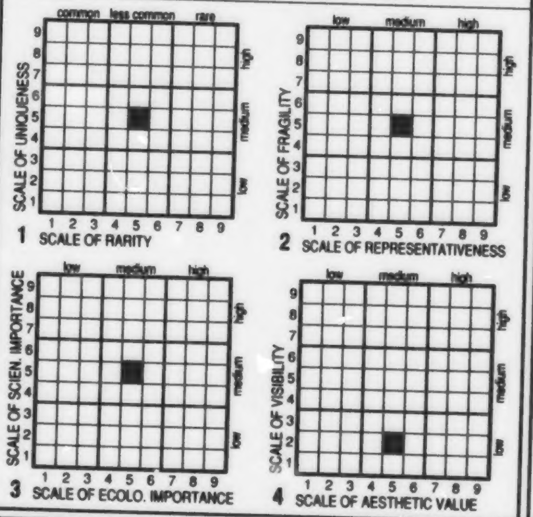


TERRESTRIAL RESOURCE VALUE QUANTIFICATION SCALES

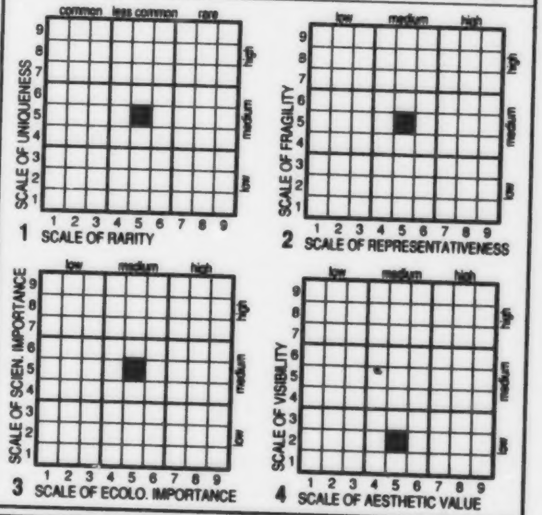
FOSSILS AT ROSS ISLAND #13



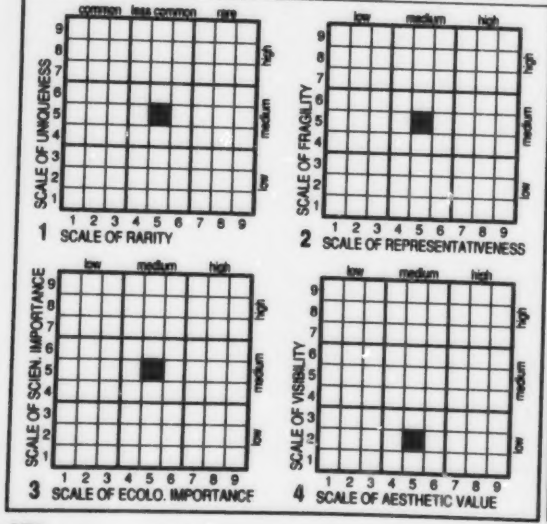
FOSSILS - NEAR POINT LANGFORD MORESBY ISLAND #14



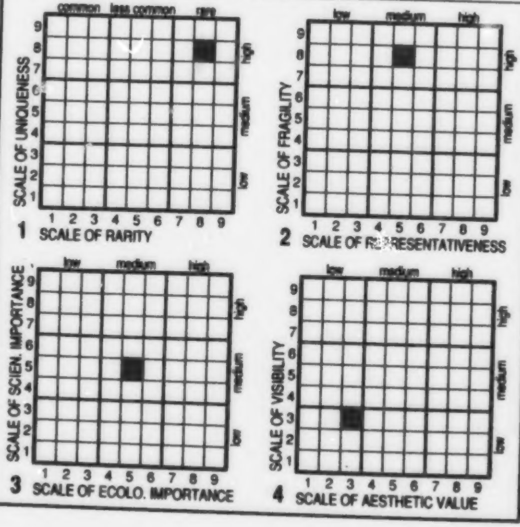
FOSSILS - WEST SIDE OF SOUTH COVE, MORESBY ISLAND #15



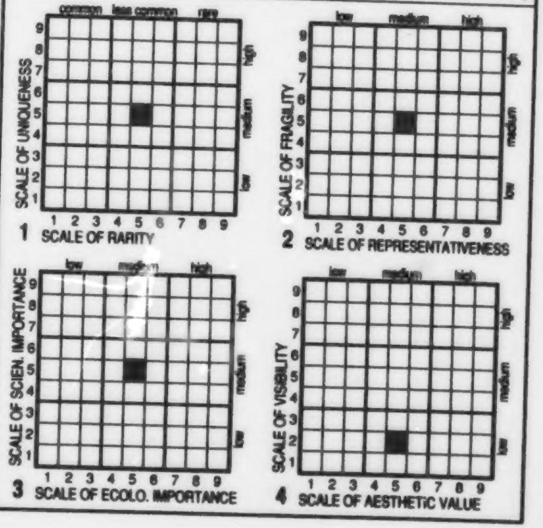
FOSSILS
IRON POINT, MORESBY ISLAND #16



THREE JAPANESE GRAVE SITES
IKEDA COVE, MORESBY ISLAND #17

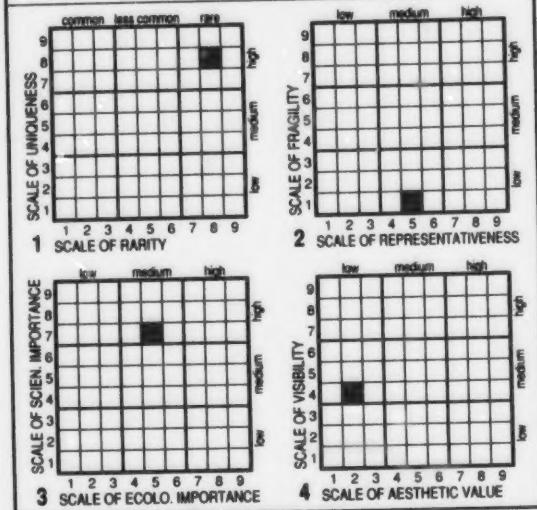


JEDWAY TOWNSITE
HARRIET HARBOUR, MORESBY ISLAND #18

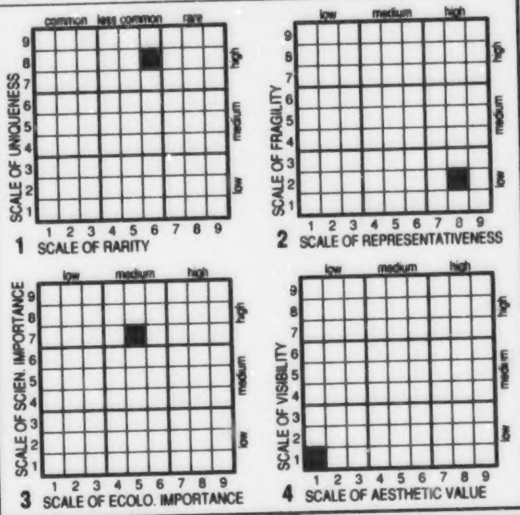


TERRESTRIAL RESOURCE VALUE QUANTIFICATION SCALES

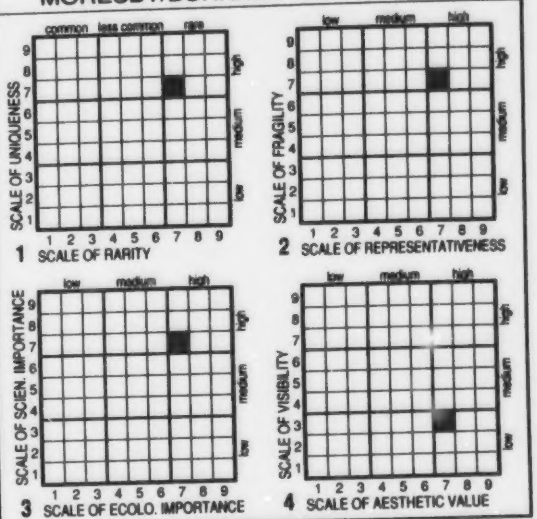
JEDWAY MINE
MORESBY ISLAND #19



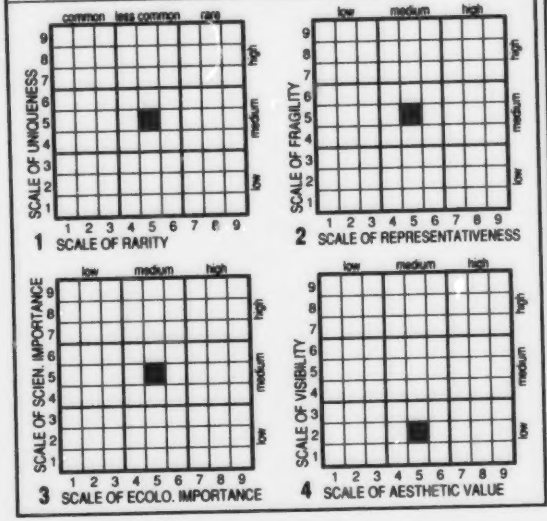
RENNEL SOUND FAULT
MORESBY ISLAND #20



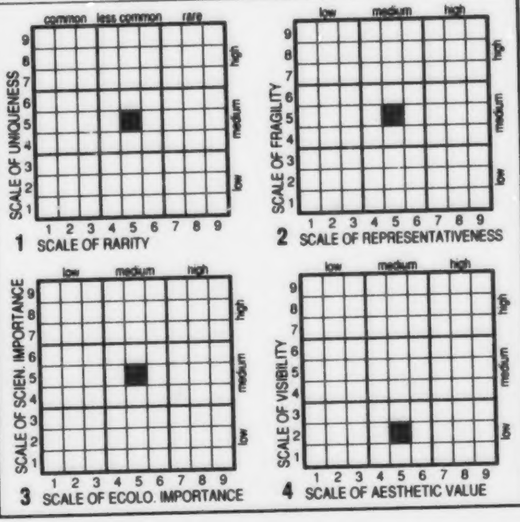
DOLOMITE NARROWS
MORESBY/BURNABY ISLANDS #21



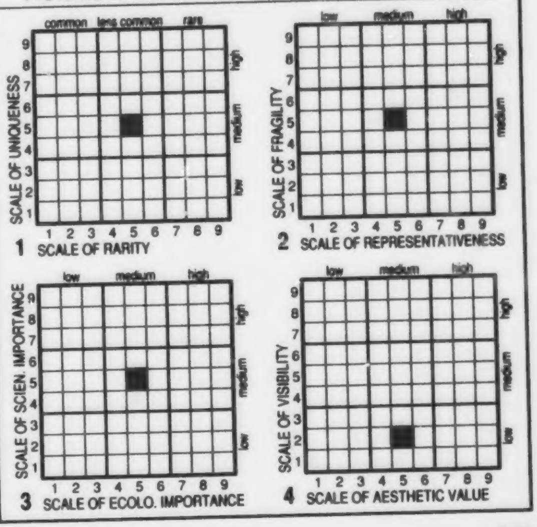
FOSSILS - NORTHEAST OF
FUNTER POINT, MORESBY ISLAND #22



FOSSILS AT SWAN ISLAND #23

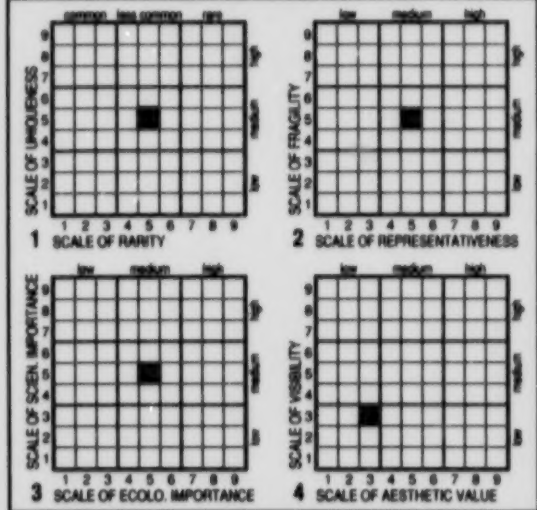


FOSSILS
POOLE INLET, MORESBY ISLAND #24

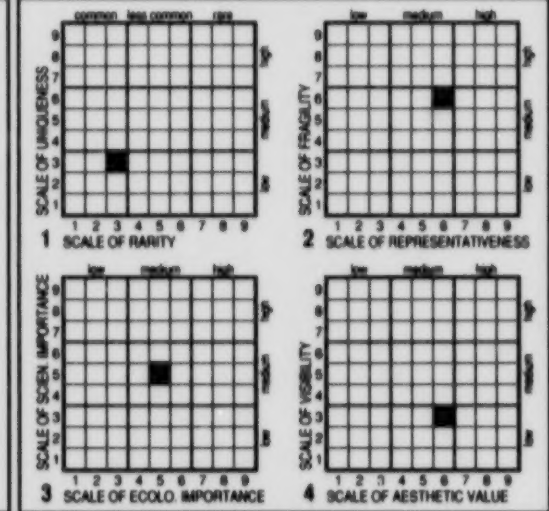


TERRESTRIAL RESOURCE VALUE QUANTIFICATION SCALES

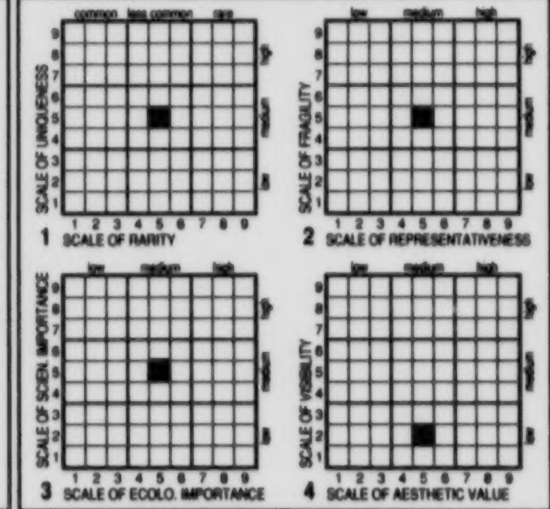
GROTTO
POOLE POINT, BURNABY ISLAND #25



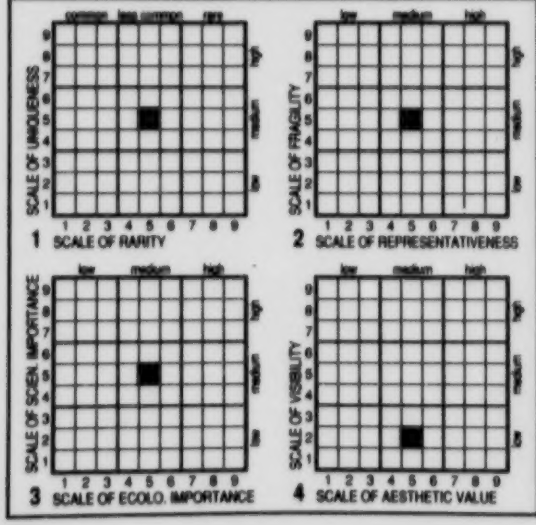
EAGLE EYRIES
BURNABY ISLAND #26



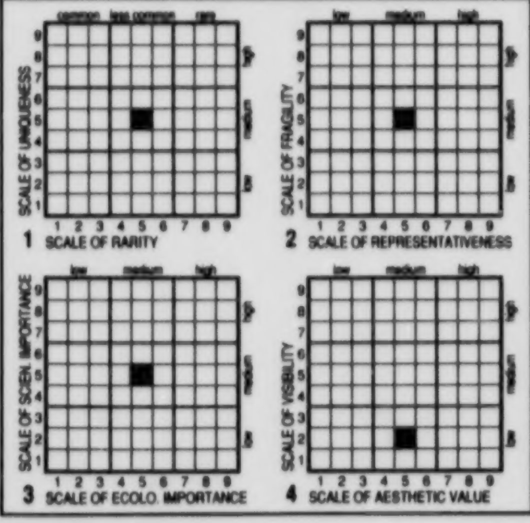
FOSSILS
PELICAN COVE, BURNABY ISLAND #27



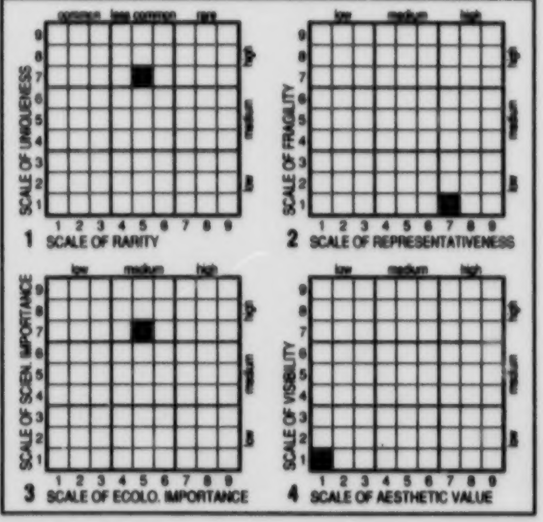
FOSSILS
HUXLEY ISLAND #28



FOSSILS
ARCHIKA ISLAND #29

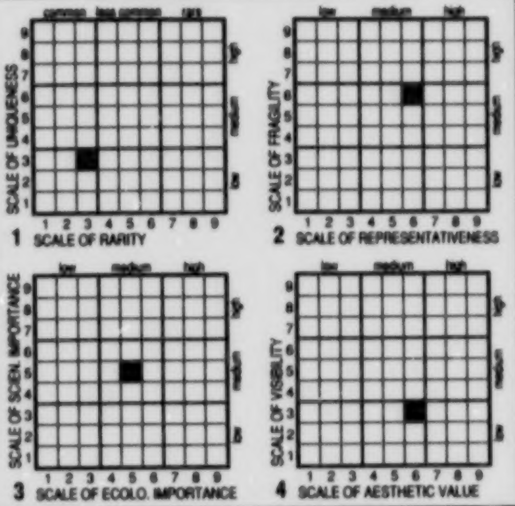


EARTHQUAKE EPICENTRE (6)
WERNER BAY, HUTTON INLET #30

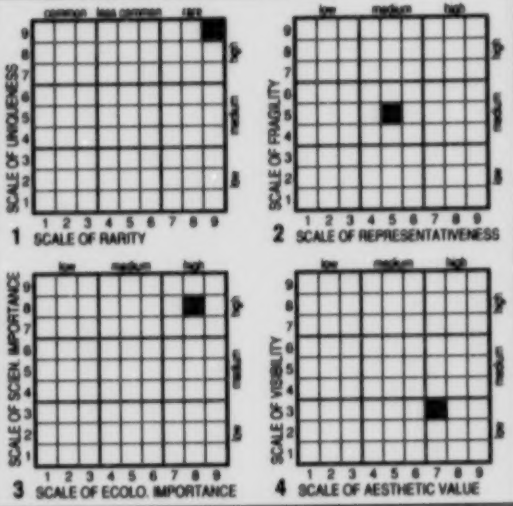


TERRESTRIAL RESOURCE VALUE QUANTIFICATION SCALES

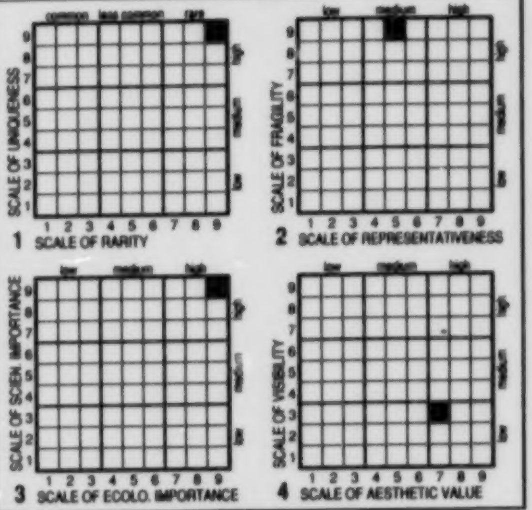
EAGLE EYRIES
RAMSEY ISLAND #31



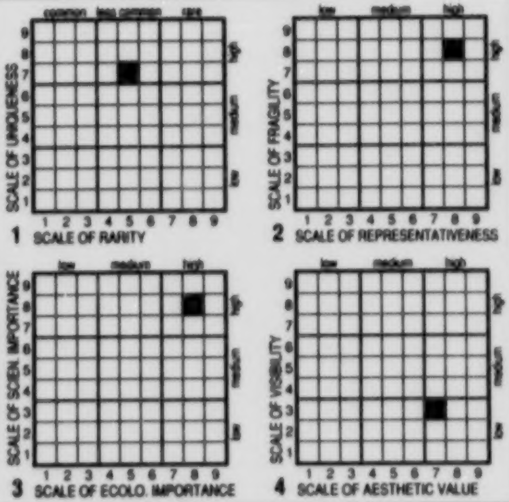
GEOTHERMAL SPRINGS
HOTSPRINGS ISLAND #32



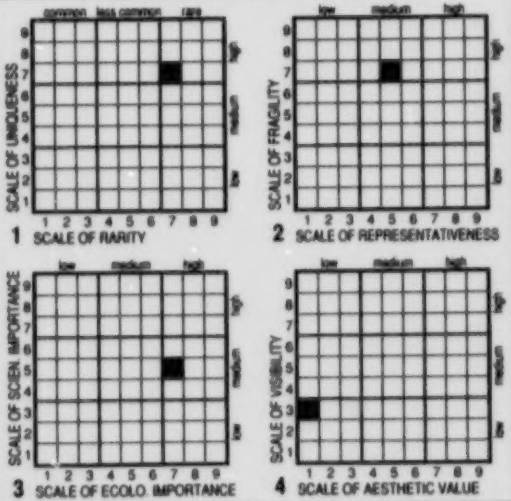
GEOTHERMAL MEADOW
HOTSPRINGS ISLAND #33



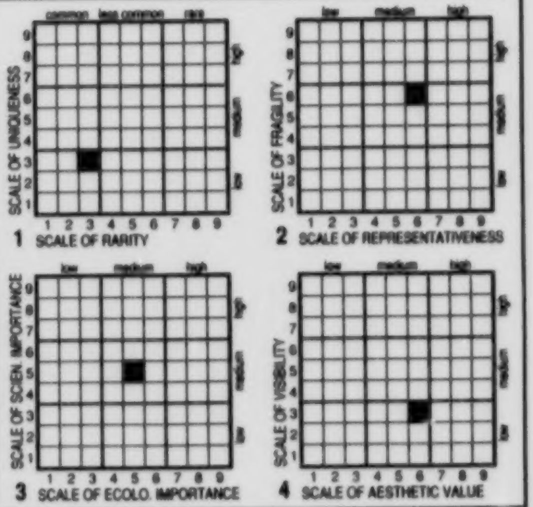
ROCK LEDGES (LUSH SEA LIFE)
FARADAY ISLAND #34



LOGGING ACTIVITIES
LYELL ISLAND #35

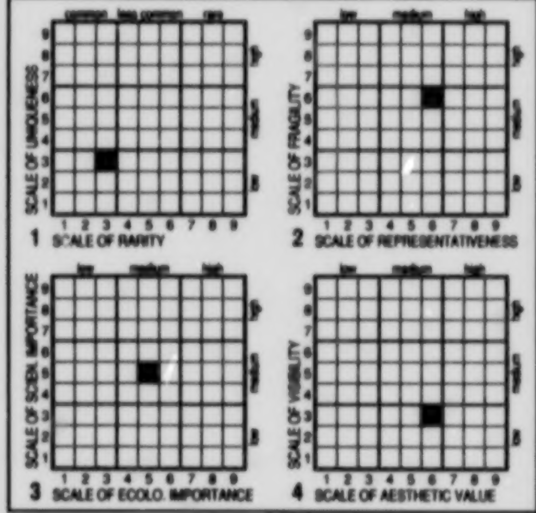


EAGLE EYRIES
LYELL ISLAND #36

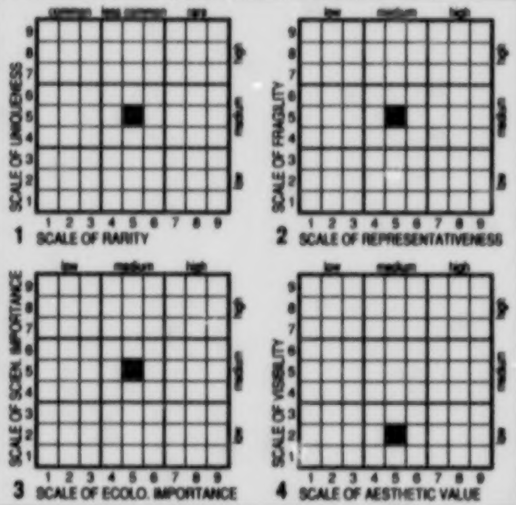


TERRESTRIAL RESOURCE VALUE QUANTIFICATION SCALES

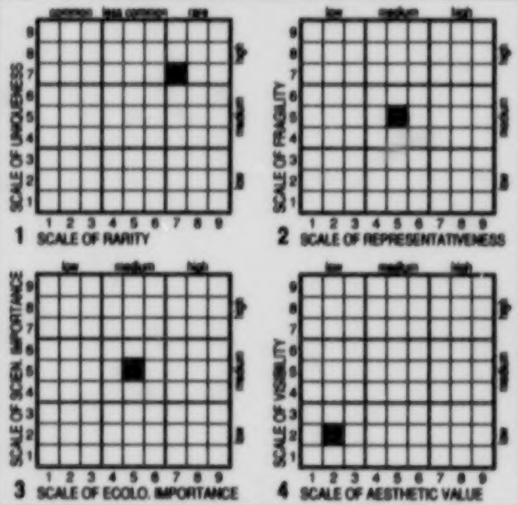
EAGLE EYRIES
RICHARDSON ISLAND #37



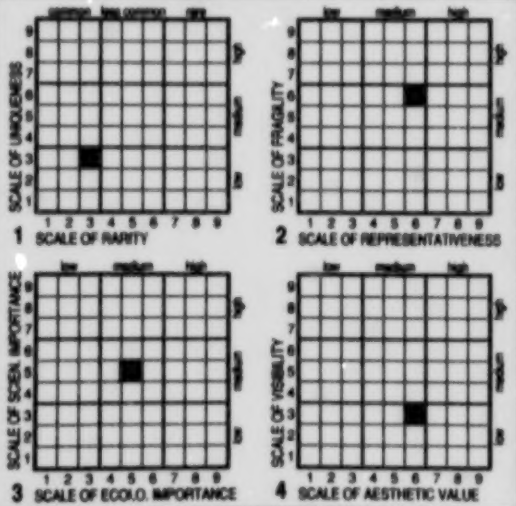
FOSSILS
GIL ISLET #38



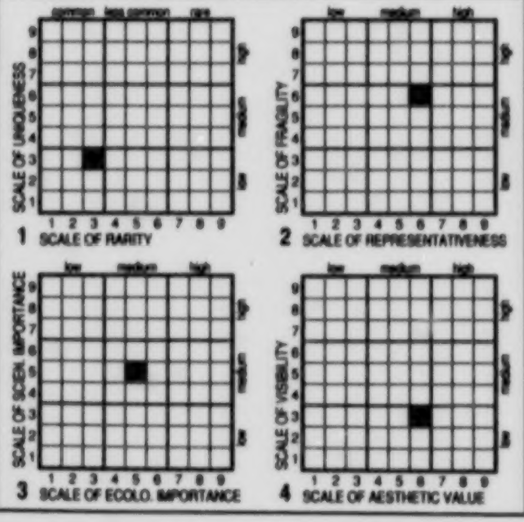
LOCKEPORT TOWNSITE
MORESBY ISLAND #39



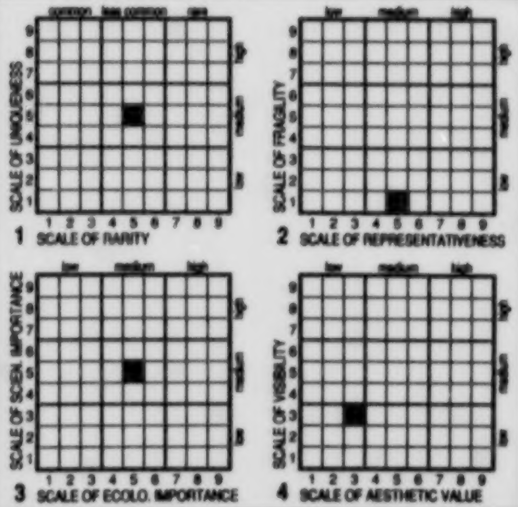
EAGLE EYRIES
TANU ISLAND #40



EAGLE EYRIES
KUNGA ISLAND #41

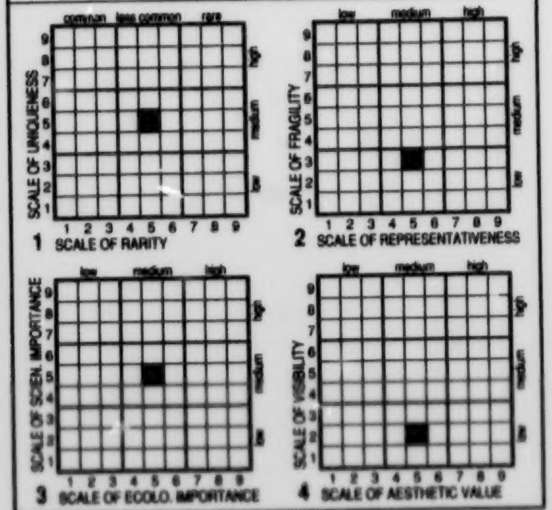


FOSSILS AT KUNGA ISLAND #42

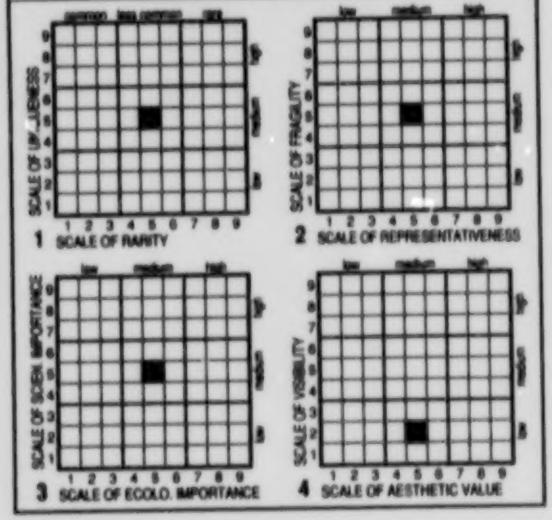


TERRESTRIAL RESOURCE V.Q.S.

FLOWER POT ISLAND
LOGAN INLET #43



PEREGRINE FALCON NEST(S)
LOST ISLAND #44



SUMMARY OF TERRESTRIAL RESOURCE VALUE QUANTIFICATION SCALES

Number		Rarity	$\frac{1}{X}$	Uniqueness	$\frac{1}{X}$	Represent.	$\frac{1}{X}$	Fragility	$\frac{1}{X}$	Ecol. Import.	$\frac{1}{X}$	Scient. Import.	$\frac{1}{X}$	Aesthetic Value	$\frac{1}{X}$	Visibility	$\frac{1}{X}$	$\frac{1}{X}$ Total
1	Queen Charlotte Fault	6	.166	8	.125	8	.125	2	.500	5	.200	7	.143	1	1.00	1	1.00	2.259
2	San Christoval Range	5	.200	5	.200	8	.125	3	.333	5	.200	5	.200	9	.111	9	.111	1.480
3	Puffin Cove, Moresby Island	3	.333	3	.333	8	.125	5	.200	5	.200	5	.200	5	.200	1	1.00	2.591
4	Louscoone Inlet Fault	2	.500	3	.333	8	.125	1	1.00	5	.200	5	.200	1	1.00	1	1.00	4.358
5	Ninstints, Anthony Island	9	.111	9	.111	9	.111	9	.111	5	.200	9	.111	9	.111	3	.333	1.199
6	Milk Quartz, Anthony Island	5	.200	5	.200	5	.200	1	1.00	5	.200	5	.200	3	.333	3	.333	2.666
7	Pillow Lava, Gordon Island	5	.200	5	.200	5	.200	3	.333	5	.200	5	.222	5	.200	2	.500	2.033
8	Fossils, Luxana Bay	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900
9	Rose Harbour, Kunghit Island	7	.143	7	.143	7	.143	7	.143	5	.200	5	.200	3	.333	3	.333	1.638
10	Fossils, Hornby Point	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900
11	Mud Flats, Sedmond Creek	6	.166	6	.166	5	.200	5	.200	5	.200	5	.200	5	.200	3	.333	1.665
12	Fossils Sedmond Creek	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900
13	Fossils, Ross Island	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900
14	Fossils, Point Langford	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900
15	Fossils, South Cove	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900
16	Fossils, Iron Point	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900
17	Japanese Graves, Ikeda Cove	8	.125	8	.125	5	.200	8	.125	5	.200	5	.200	3	.333	3	.333	1.641
18	Jedway Townsite, Moresby Is.	7	.143	7	.143	5	.200	3	.333	5	.200	5	.200	5	.200	3	.333	1.752
19	Jedway Mine, Moresby Island	8	.125	8	.125	5	.200	1	1.00	5	.200	7	.143	2	.500	4	.250	2.543
20	Rennel Sound Fault	6	.166	8	.125	8	.125	2	.500	5	.200	7	.143	1	1.00	1	1.00	3.259
21	Dolomite Narrows	7	.143	7	.143	7	.143	7	.143	7	.143	7	.143	7	.143	3	.333	1.334
22	Fossils, Funter Point	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900

SUMMARY OF TERRESTRIAL RESOURCE VALUE QUANTIFICATION SCALES

Number		Rarity	$\frac{1}{\bar{x}}$	Uniqueness	$\frac{1}{\bar{x}}$	Represent.	$\frac{1}{\bar{x}}$	Fragility	$\frac{1}{\bar{x}}$	Ecol. Import.	$\frac{1}{\bar{x}}$	Scient. Import.	$\frac{1}{\bar{x}}$	Aesthetic Value	$\frac{1}{\bar{x}}$	Visibility	$\frac{1}{\bar{x}}$	$\frac{1}{x}$ Total
23	Fossils, Swan Island	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900
24	Fossils, Poole Inlet	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900
25	Grotto, Poole Point	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	3	.333	3	.333	1.866
26	Eagle Eyries, Burnaby Island	3	.333	3	.333	6	.166	6	.166	5	.200	5	.200	6	.166	3	.333	1.897
27	Fossils, Pelican Cove	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900
28	Fossils, Huxley Island	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900
29	Fossils, Arichika Island	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900
30	Earthquake Epicentre	5	.200	7	.143	7	.143	1	1.00	5	.200	7	.143	1	1.00	1	1.00	3.829
31	Eagle Eyries, Ramsay Island	3	.333	3	.333	6	.166	6	.166	5	.200	5	.200	6	.166	3	.333	1.897
32	Geothermal Spr., Hotsprings Is.	9	.111	9	.111	5	.200	5	.200	8	.125	8	.125	7	.143	3	.333	1.348
33	Geothermal Mead., Hotsprings I.	9	.111	9	.111	5	.200	9	.111	9	.111	9	.111	7	.143	3	.333	1.231
34	Rock Ledges, Faraday Island	5	.200	7	.143	8	.125	8	.125	8	.125	8	.125	7	.143	3	.333	1.319
35	Logging, Lyle Island	7	.143	7	.143	5	.200	7	.143	7	.143	5	.200	1	1.00	3	.333	2.505
36	Eagle Eyries, Lyell Island	3	.333	3	.333	6	.166	6	.166	5	.200	5	.200	6	.166	3	.333	1.897
37	Eagle Eyries, Richardson Island	3	.333	3	.333	6	.166	6	.166	5	.200	5	.200	6	.166	3	.333	1.897
38	Fossils, Gil Islet	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900
39	Lockeport Townsite	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900
40	Eagle Eyries, Tanu Island	3	.333	3	.333	6	.166	6	.166	5	.200	5	.200	6	.166	3	.333	1.897
41	Eagle Eyries, Kunga Island	3	.333	3	.333	6	.166	6	.166	5	.200	5	.200	6	.166	3	.333	1.897
42	Fossils, Kunga Island	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	2	.500	1.900
43	Flowerpot Island	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	5	.200	1.600
44	Peregrine Falcons, Lost Island	7	.143	7	.143	7	.143	7	.143	7	.143	7	.143	8	.125	4	.250	1.233

TOTAL "PARK VALUE" SCALE (TERRESTRIAL)

PRI-ORITY NO.	FEATURE, SITE, AREA, ETC.	TOTAL PARK VALUE RATIO
1	Ninstints, Anthony Island	1.199
2	Geothermal Meadow, Hotsprings Island	1.231
3	Peregrine Falcon Nests, Lost Island	1.233
4	Rock Ledges, Faraday Island	1.319
5	Dolomite Narrows, Moresby/Burnaby Is.	1.334
6	Geothermal Springs, Hotsprings Island	1.348
7	San Christovol Range, Moresby Island	1.480
8	Flower Pot Island	1.600
9	Rose Harbour, Kunghit Island	1.638
10	Japanese Graves, Ikeda Cove, Moresby Is.	1.641
11	Mud Flats, Sedmond Creek, Moresby Is.	1.665
12	Jedway Townsite, Moresby Island	1.752
13	Grotto, Poole Point, Burnaby Island	1.866
14	Eagle Eyries, Burnaby Island	1.897
15	Eagle Eyries, Ramsey Island	1.897
16	Eagle Eyries, Lyell Island	1.897
17	Eagle Eyries, Richardson Island	1.897
18	Eagle Eyries, Tanu Island	1.897
19	Eagle Eyries, Kunga Island	1.897
20	Fossils, Luxana Bay, Kunghit Island	1.900
21	Fossils, Hornby Point, Kunghit Island	1.900
22	Fossils, Sedmond Creek, Moresby Island	1.900

PRI-ORITY NO.	FEATURE, SITE, AREA, ETC.	TOTAL PARK VALUE RATIO
23	Fossils, Ross Island	1.900
24	Fossils, Point Langford, Moresby Island	1.900
25	Fossils, South Cove, Moresby Island	1.900
26	Fossils, Iron Point, Moresby Island	1.900
27	Funter Point, Moresby Island	1.900
28	Fossils, Swan Island	1.900
29	Fossils, Poole Inlet, Burnaby Island	1.900
30	Fossils, Pelican Cove, Burnaby Island	1.900
31	Fossils, Huxley Island	1.900
32	Fossils, Arichika Island	1.900
33	Fossils, Gil Islet	1.900
34	Fossils, Kunga Island	1.900
35	Lockeport Townsite, Moresby Island	1.900
36	Pillow Lava, Gordon Island	2.033
37	Queen Charlotte Fault	2.259
38	Logging, Lyell Island	2.505
39	Jedway Mine, Moresby Island	2.543
40	Puffin Cove, Moresby Island	2.591
41	Milk Quartz, Anthony Island	2.666
42	Rennell Sound Fault	3.259
43	Earthquake Epicentre, Werner Bay	3.829
44	Louscoone Inlet Fault, Moresby Island	4.358

a) RESOURCE ANALYSIS

The area encompassed by the South Moresby / Gwaii Haanas National Park Reserve contains a most peculiar mix of natural and man-made resources. Even at this very early stage of resource analysis, this national park reserve appears to be unlike most other national parks in that respect. Only a very few national parks in the system contain remnants of past resource use and extraction activities of the same kind of density and intensity with which they are spread throughout this park reserve area.

While it is relatively easy to evaluate natural resources for their degree of visibility and ecological sensitivity, the same can not be said for the man-made historical resources. Many of the latter resources have already been reclaimed by natural processes, as well as having undergone selective removals of commercially valuable items and partial rehabilitations. In addition, the availability of any written records of and about such resources, is not readily obvious. A concentrated effort is required to search for and synthesize any records that may have survived through time, and thereby provide the background information base from which to finalize the real historical value, visibility, and ecological sensitivity of the resources that could thus far only be treated superficially.

- Management Concerns

The primary management concerns arising out of this section of the resource description are based on the perception that our knowledge about the actual value of the resources identified is at best very limited. The assumption can also be made that there appear to exist a large number of historically and ecologically sensitive features, sites, and areas which have yet to be identified and evaluated. It is therefore most difficult at this time to determine the proper levels of resource management required to achieve the long-term mandate of national parks; that is, besides providing for their protection. A serious effort must be undertaken to fill the information gaps before any management decisions are made that have the potential to irreversibly alter the quality and value of any of the highly visible, and historically and ecologically sensitive resources.

- Status of Knowledge

The current status of our knowledge is inadequate for resource management purposes, and remains based primarily on published works that have not really treated the subject matter in depth. The requirement exists to seriously improve our status of knowledge.

b) SELECT REFERENCE SOURCES

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Landscape Aesthetics: How to Quantify the Scenics of a River Valley. J. Nat. Hist., Amer. Mus. Nat. Hist. pp. 37-44.

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B. SENSITIVE MARINE RESOURCES

As is the case with the tabulated evaluation of the sensitivity of the terrestrial resources of the park reserve, the following application of Leopold's modified landscape quantification methodology (Leopold 1969) to select natural resources of the proposed South Moresby/Gwaii Haanas National Marine Park Reserve is based on the review of the existing literature and as such must be treated as a first approximation. As the biophysical data base is developed for the park reserve and the general level of knowledge of the marine resources is raised through research and survey work, the matrices can be amended and expanded to reflect that sounder understanding of the marine environment. A similarity of park value ratios amongst like features is a reflection not so much of the likeness of features as it is of an unwillingness of the evaluator to discriminate between similar types of sites (*e.g.*, seabird colonies) on the basis of little information. Furthermore, as a first approximation, the ranking is necessarily conservative.

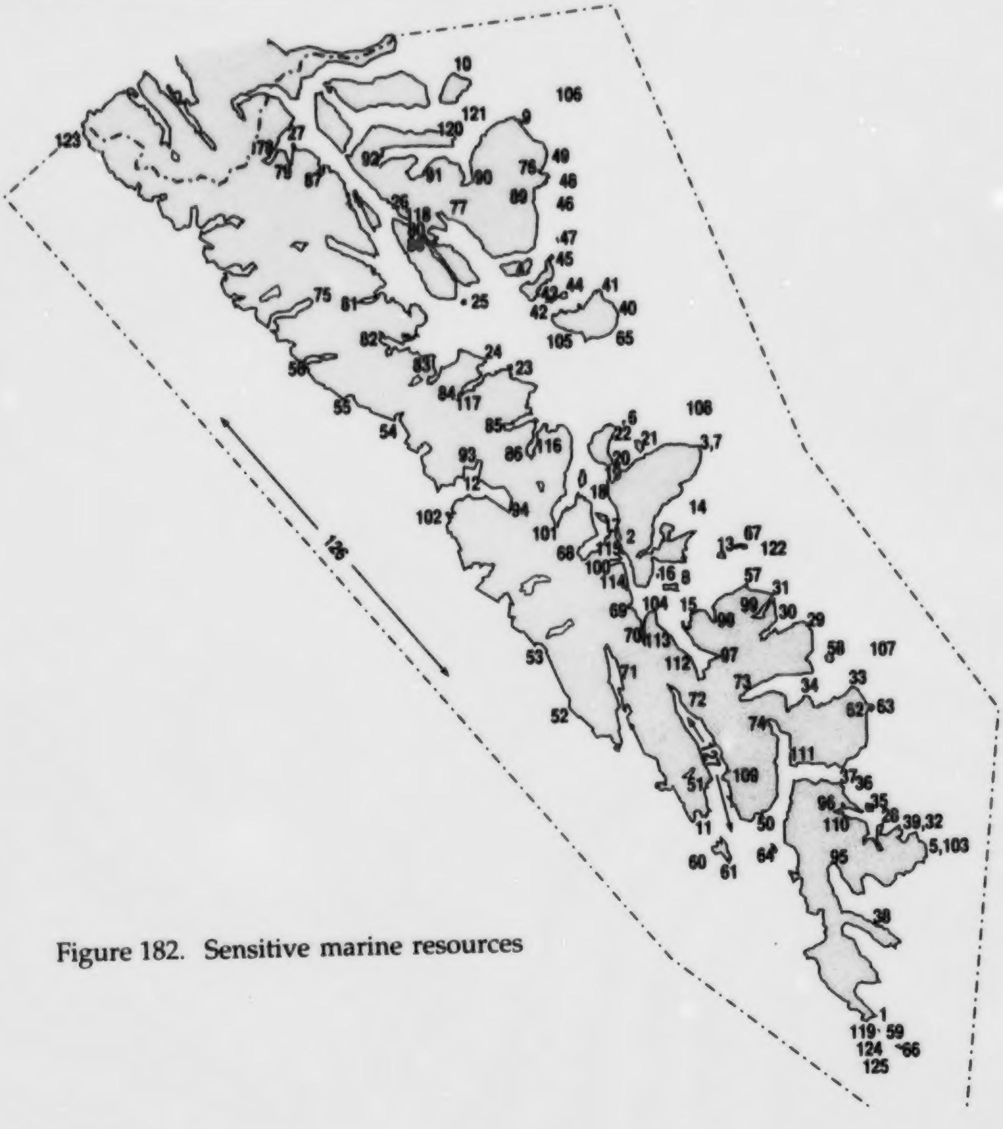
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Figure 182. Sensitive marine resources

Sensitive Marine Features

No.	Natural Feature :	Marine Reserve Locality :	Resource :
1	Mammal/Seabird Colony	St. James Island	Zoological
2	Marine Life	Dolomite Narrows	Zoological
3	Sea Lion Rafting	NW of Scudder Pt., Burnaby Isl.	Zoological
4	Marine Life	Rock Ledges, Faraday Island	Zoological
5	Seabird Colonies	Lyman Point, Kunghit Island	Ornithological
6	Seabird Colonies	Arichika Island	Ornithological
7	Seabird Colonies	Scudder Pt., Burnaby Island	Ornithological
8	Seabird Colonies	Bolkus Islands	Ornithological
9	Seabird Colonies	Dodge Pt., Lyell Island	Ornithological
10	Seabird Colonies	Kunga Isl. & Titul Island	Ornithological
11	Seabird Colonies	Adam Rks., Louscoone Inlet	Ornithological
12	Seabird Colonies	Islands in Gowgaia & Goski Bays	Ornithological
13	Seabird Colonies	Copper Islands & Adjacent Islets	Ornithological
14	Seabird Colonies	Howay Islands	Ornithological
15	Seabird Colonies	Bush Rk. & Adj. Islets in Jedway Bay & Houston Inlet	Ornithological
16	Seabird Colonies	Swan Island	Ornithological
17	Seabird Colonies	Islets West of Dolomite Point	Ornithological
18	Seabird Colonies	Wanderer Island. & Adj. Islets	Ornithological
19	Seabird Colonies	Islets South of Huxley Island	Ornithological
20	Seabird Colonies	Nakons Inlet	Ornithological
21	Seabird Colonies	Alder Island	Ornithological
22	Seabird Colonies	East Shore, Huxley Island	Ornithological
23	Seabird Colonies	Marco Isl. & Adj. Islets	Ornithological
24	Seabird Colonies	Hoskins Islets	Ornithological
25	Seabird Colonies	Bischof Islands	Ornithological
26	Seabird Colonies	Unnamed Island, Shuttle Passage	Ornithological
27	Seabird Colonies	Gil Islet	Ornithological
28	Seabird Colonies	Rainy Islands	Ornithological
29	Seabird Colonies	Goodwin Point	Ornithological
30	Seabird Colonies	Nest Islets	Ornithological
31	Seabird Colonies	Inner Low Rock	Ornithological
32	Seabird Colonies	Gull Inlet	Ornithological
33	Seabird Colonies	Langtry Islands	Ornithological
34	Seabird Colonies	Islets in Carpenter Bay	Ornithological
35	Seabird Colonies	High Island	Ornithological
36	Seabird Colonies	Haydon Rock	Ornithological
37	Seabird Colonies	Rocky Islets NW of Moore Head, Kunghit Island	Ornithological
38	Seabird Colonies	N shore of Annis Pt. Peninsula	Ornithological
39	Seabird Colonies	Islet in Bay, West of Lyman Point, Kunghit Island	Ornithological
40	Seabird Colonies	Yadus Point, Ramsay Island	Ornithological
41	Seabird Colonies	Is. N of Andrew Pt., Ramsay Isl.	Ornithological
42	Seabird Colonies	Islet SW of Hotsprings Isl., betw. Murchison Isl. & Ramsay Pt.	Ornithological

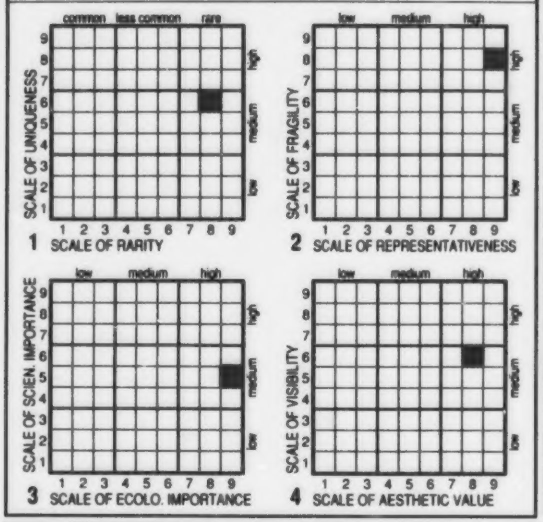
No.	Natural Feature :	Marine Reserve Locality :	Resource :
43	Seabird Colonies	Hotsprings Island	Ornithological
44	Seabird Colonies	House Island	Ornithological
45	Seabird Colonies	Murchison Island	Ornithological
46	Seabird Colonies	Islets between Tar Islands & Agglomerate Island	Ornithological
47	Seabird Colonies	Agglomerate Island	Ornithological
48	Seabird Colonies	Tar Islands	Ornithological
49	Seabird Colonies	Tuft Islands	Ornithological
50	Seabird Colonies	Flatrock Island	Ornithological
51	Seabird Colonies	Tuga Point	Ornithological
52	Seabird Colonies	Rocky Headland North of McLean Fraser Point	Ornithological
53	Seabird Colonies	Rocky Point, West of Lower Victoria Lake Estuary	Ornithological
54	Seabird Colonies	Island South of unnamed Bay, South of Puffin Cove	Ornithological
55	Seabird Colonies	Island West of Puffin Cove	Ornithological
56	Seabird Colonies	South Point of Mike Inlet	Ornithological
57	Mammal/Seabird Colony	New England & Joyce Rocks	Zoological
58	Mammal/Seabird Colony	Rankine Island	Zoological
59	Mammal/Seabird Colony	Kerouard Islands	Zoological
60	Mammal/Seabird Colony	Anthony Island	Zoological
61	Seabird Staging Area	Southeast of Anthony Island	Ornithological
62	Mammal/Seabird Colony	Benjamin Point	Zoological
63	Mammal/Seabird Colony	Garcin Rocks	Zoological
64	Mammal/Seabird Colony	Gordon Islets	Zoological
65	Mammal/Seabird Colony	Tatsung Rock	Zoological
66	Seabird Staging Area	Surrounding St. James Island & Kerouard Islets	Ornithological
67	Seabird Staging Area	Northeast of Copper Islands	Ornithological
68	Tidal Flat/Marsh	Island Bay	Bot./Zoological
69	Tidal Flat/Marsh	George Bay	Bot./Zoological
70	Tidal Flat/Marsh	Slim Inlet	Bot./Zoological
71	Tidal Flat/Marsh	Flamingo Inlet	Bot./Zoological
72	Tidal Flat/Marsh	Louscoone Inlet	Bot./Zoological
73	Tidal Flat/Marsh	Carpenter Bay	Bot./Zoological
74	Tidal Flat/Marsh	Rose Inlet	Bot./Zoological
75	Tidal Flat/Marsh	Barry Inlet	Bot./Zoological
76	Tidal Flat/Marsh	Bay North of Gogit Point	Bot./Zoological
77	Tidal Flat/Marsh	Sedgewick Bay	Bot./Zoological
78	Tidal Flat/Marsh	Anna Inlet	Bot./Zoological
79	Tidal Flat/Marsh	McEchran Cove	Bot./Zoological
80	Tidal Flat/Marsh	Lyell Bay	Bot./Zoological
81	Tidal Flat/Marsh	Kostan Inlet	Bot./Zoological
82	Tidal Flat/Marsh	De la Beche Inlet	Bot./Zoological
83	Tidal Flat/Marsh	Haswell Bay	Bot./Zoological
84	Tidal Flat/Marsh	Hutton Inlet	Bot./Zoological
85	Tidal Flat/Marsh	Marshall Inlet	Bot./Zoological

No.	Natural Feature :	Marine Reserve Locality :	Resource :
86	Tidal Flat/Marsh	Matheson Inlet	Bot./Zoological
87	Tidal Flat/Marsh	Echo Harbour	Bot./Zoological
88	Tidal Flat/Marsh	Beresford Inlet	Bot./Zoological
89	Tidal Falt/Marsh	Windy Bay	Bot./Zoological
90	Tidal Flat/Marsh	Powrivco Bay	Bot./Zoological
91	Tidal Flat/Marsh	Beljay Bay	Bot./Zoological
92	Tidal Flat/Marsh	Takelly Cove	Bot./Zoological
93	Tidal Flat/Marsh	Goski Bay	Bot./Zoological
94	Tidal Flat/Marsh	Yaklanas Bay	Bot./Zoological
95	Tidal Flat/Marsh	Luxana Bay	Bot./Zoological
96	Tidal Flat/Marsh	Heater Harbour	Bot./Zoological
97	Tidal Flat/Marsh	Huston Inlet	Bot./Zoological
98	Tidal Flat/Marsh	Harriet Harbour	Bot./Zoological
99	Tidal Flat/Marsh	Ikeda Cove	Bot./Zoological
100	Tidal Flat/Marsh	Bag Harbour	Bot./Zoological
101	Tidal Flat/Marsh	Skaat Harbour	Bot./Zoological
102	Mammal/Seabird Colony	Gowdas Rocks	Zoological
103	Seabird Staging Area	E of Lyman Point, Kunghit Island	Ornithological
104	Seabird Staging Area	South of Bolkus Islands	Ornithological
105	Seabird Staging Area	W & S of Ramsay Isl. & House Isl.	Ornithological
106	Seabird Staging Area	East of Dodge Point, Lyell Island	Ornithological
107	Seabird Staging Area	East of Rankine Island	Ornithological
108	Seabird Staging Area	North of Alder Island	Ornithological
109	Archaeological Site	N of Etches Pt., Louscoone Inlet	Historical
110	Archaeological Site	Heater Harbour	Historical
111	Archaeological Site	Ross Island	Historical
112	Archaeological Site	Huston Inlet	Historical
113	Archaeological Site	Slim Inlet	Historical
114	Archaeological Site	Bag Harbour	Historical
115	Archaeological Site	Near Dolomite Point, Islands Bay	Historical
116	Archaeological Site	Matheson Inlet	Historical
117	Archaeological Site	Hutton Inlet	Historical
118	Archaeological Site	Lyell Bay	Historical
119	Wreck of the Seagull	Off Cape St. James (1889)	Historical
120	Wreck of the Lark	Off Porter Head (1786)	Historical
121	Wreck of the San Thomas	Off Porter Head (1958)	Historical
122	Wreck of the Scrub	Off Copper Islands (1950)	Historical
123	Wreck of the Superior	Off Tasu Sound (1948)	Historical
124	Wreck of the Thelma G.	Off Cape St. James (1930)	Historical
125	Wreck of the Galiano	Off Cape St. James (1918)	Historical
126	Queen Charlotte Fault	Off the West Coast	Geological
127	Louscoone Inlet Fault	Louscoone Inlet	Geological

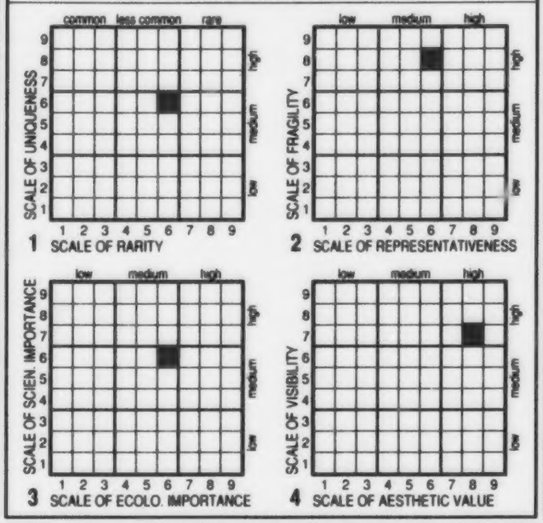
In those cases where unfamiliarity with the reserve area, a lack of knowledge, or a lack of quantifiable data prevented the assignment of a rated resource value, a median rating of 5 was assigned pending a more certain evaluation.

MARINE RESOURCE VALUE QUANTIFICATION SCALES

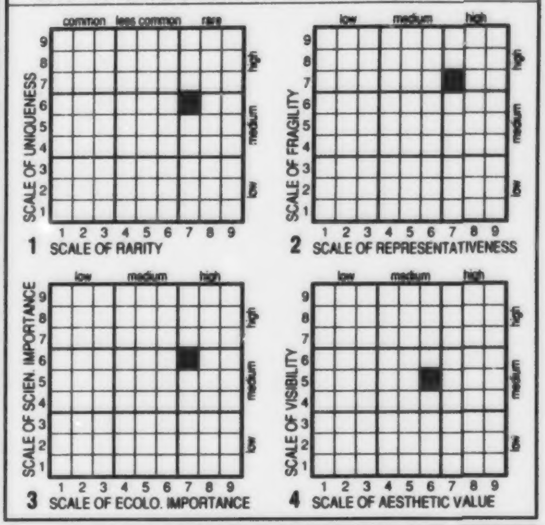
MARINE MAMMALS/SEABIRD COLONY
ST. JAMES ISLAND #1



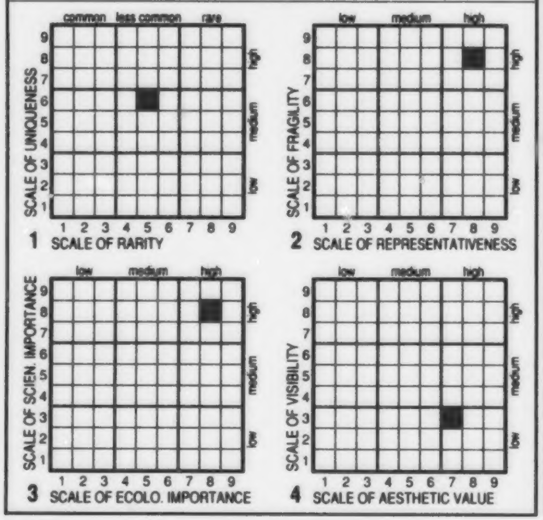
MARINE LIFE
DOLOMITE NARROWS #2



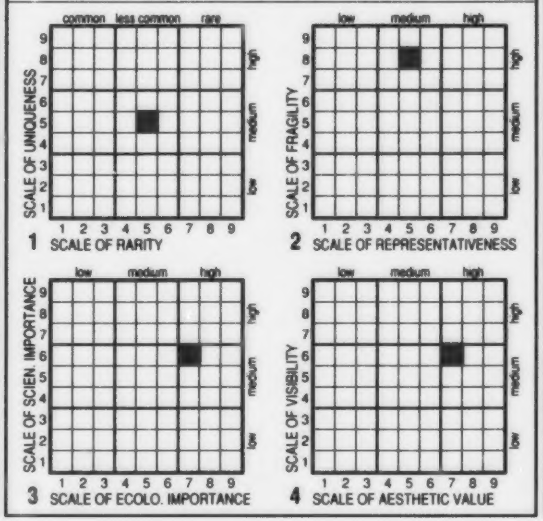
SEA LION RAFTING AREA
NW OF SCUDDER PT., BURNABY IS. #3



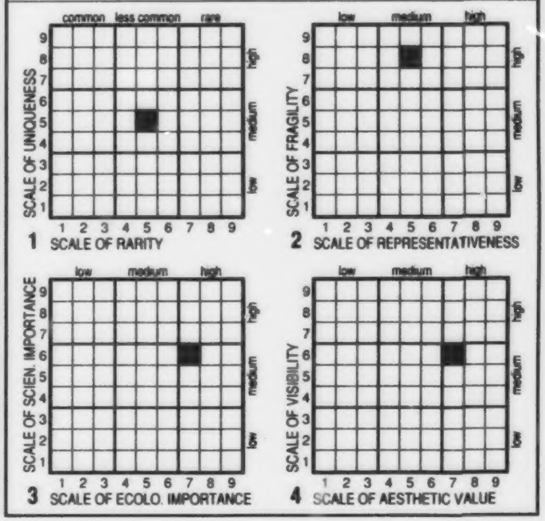
MARINE LIFE
FARADAY ISLAND #4



SEABIRD COLONIES
LYMAN POINT, KUNGHIT ISLAND #5

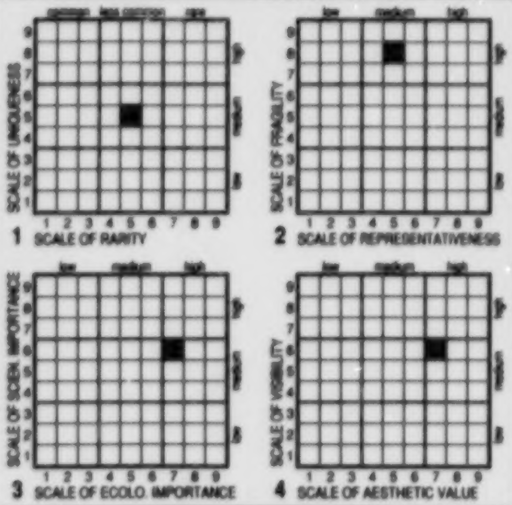


SEABIRD COLONIES
ARICHIKA ISLAND #6

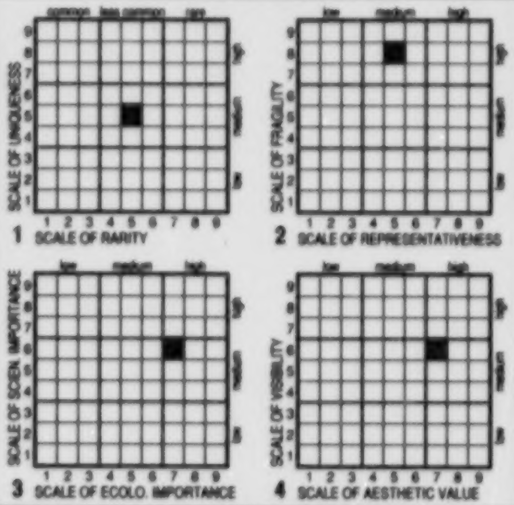


MARINE RESOURCE VALUE QUANTIFICATION SCALES

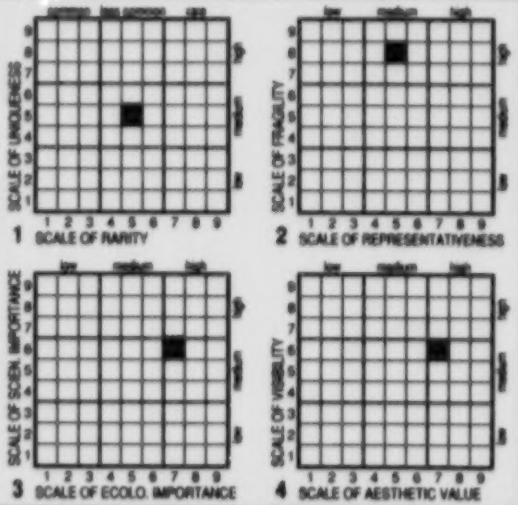
SEABIRD COLONIES
SCUDDER PT., BURNABY ISLAND #7



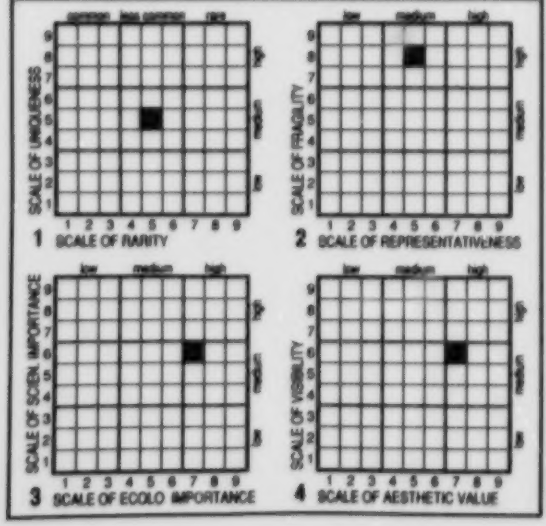
SEABIRD COLONIES
BOLKUS ISLANDS #8



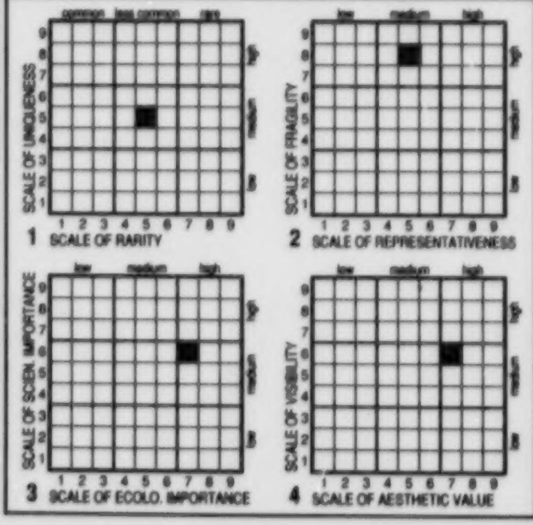
SEABIRD COLONIES
DODGE POINT, LYELL ISLAND #9



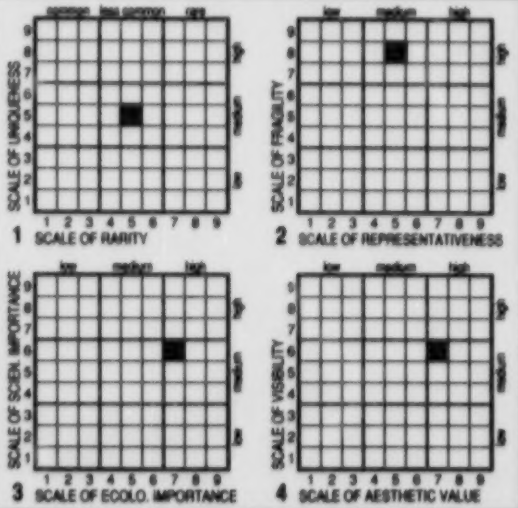
SEABIRD COLONIES
KUNGA & TITUL ISLANDS #10



SEABIRD COLONIES
ADAM ROCKS, LOUSCOONE INLET #11

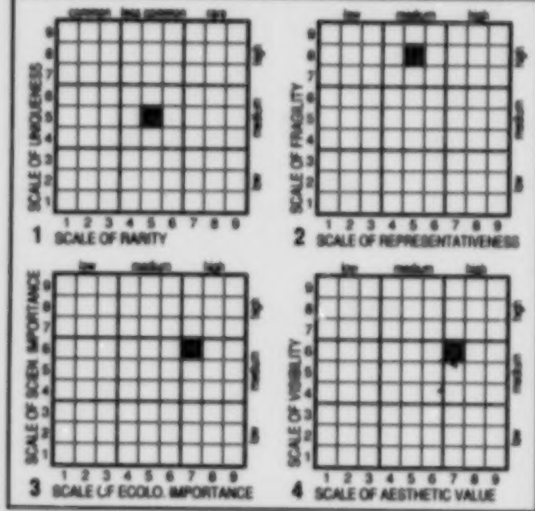


SEABIRD ROOKERY
ISLANDS IN GOWGAIA & GOSKI BAYS #12



MARINE RESOURCE VALUE QUANTIFICATION SCALES

SEABIRD COLONIES
COPPER IS. & ADJACENT ISLETS #13



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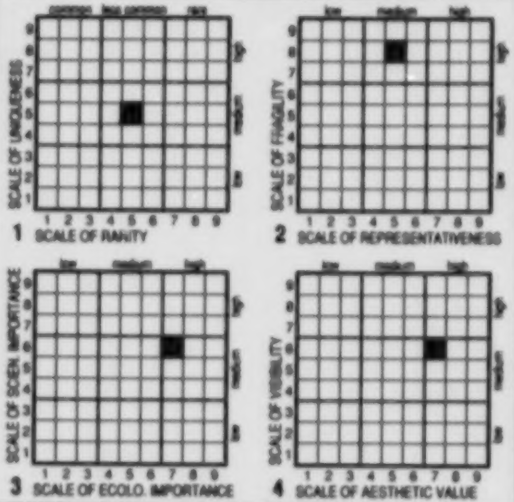
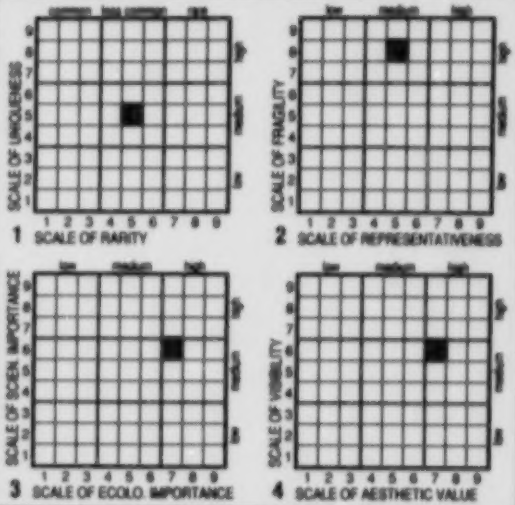
HOWAY ISLANDS #14



SEABIRD COLONY - BUSH ROCK & ISLETS
IN JEDWAY BAY & HUSTON INLET #15



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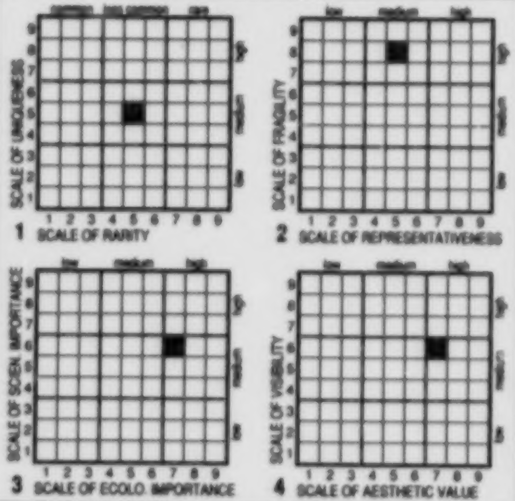
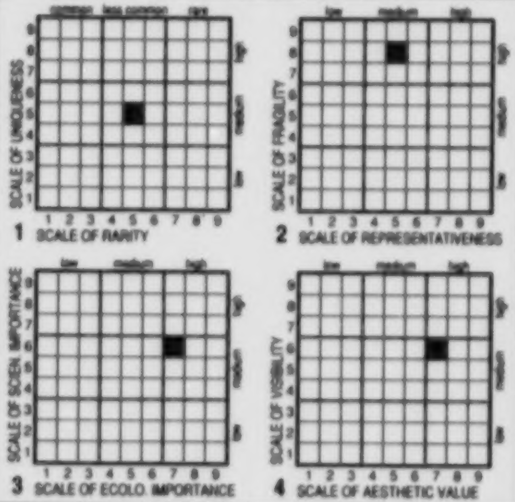
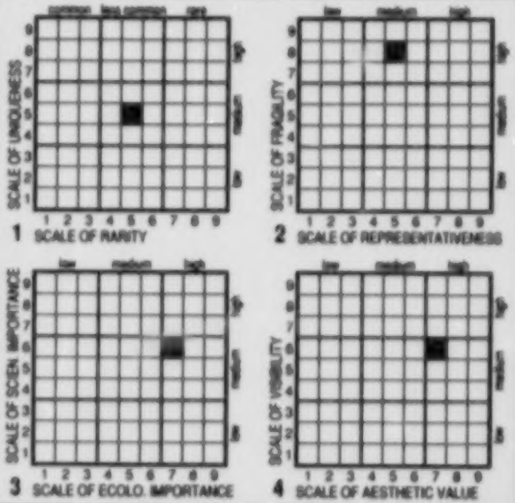
SWAN ISLAND #16



SEABIRD COLONY
ISLETS WEST OF DOLOMITE POINT #17

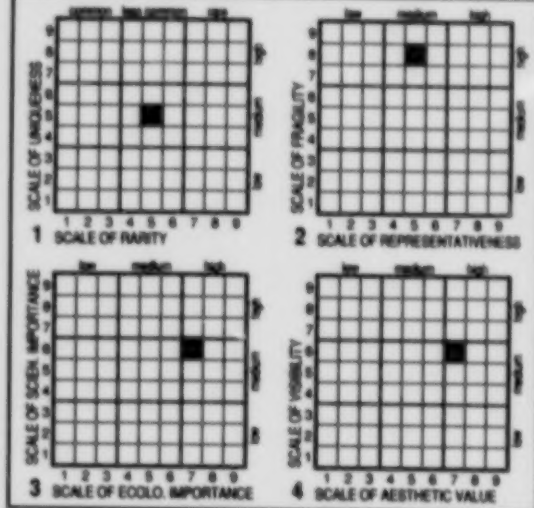


SEABIRD COLONY
WANDERER IS. & ADJACENT ISLETS #18

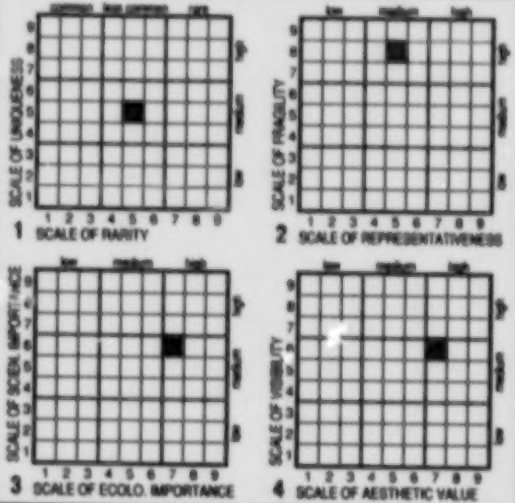


MARINE RESOURCE VALUE QUANTIFICATION SCALES

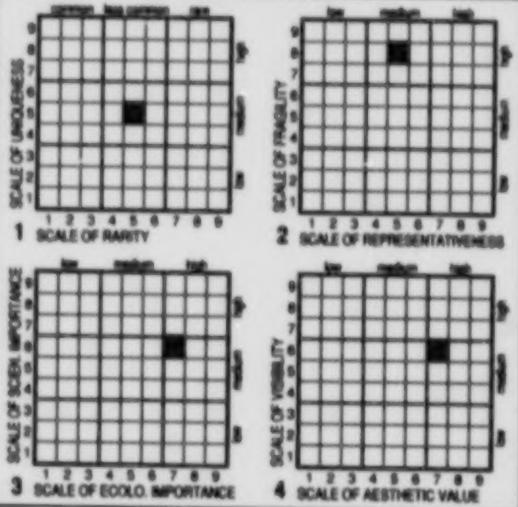
SEABIRD COLONY
ISLET SOUTH OF HUXLEY ISLAND #19



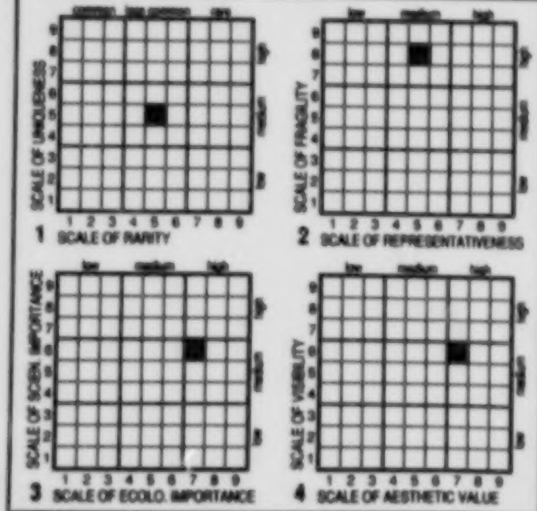
SEABIRD COLONY
NAKONS ISLET #20



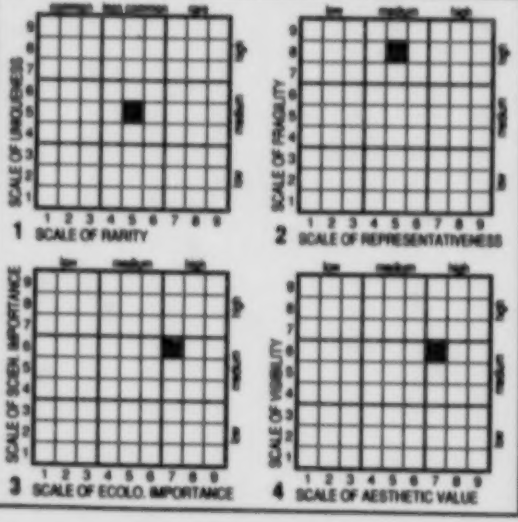
SEABIRD COLONY
ALDER ISLAND #21



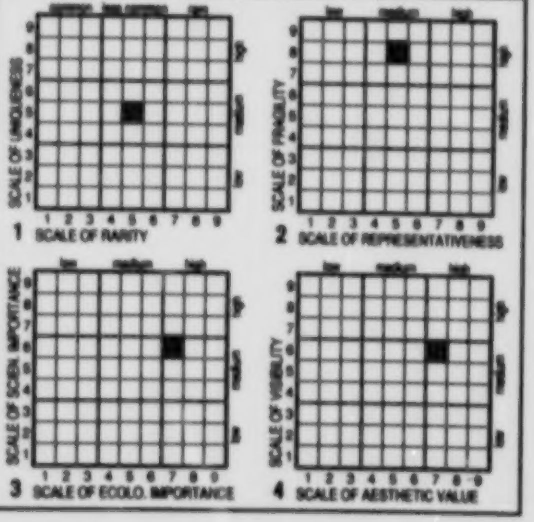
SEABIRD COLONY
EAST SHORE, HUXLEY ISLAND #22



SEABIRD COLONY
MARCO ISLAND & ADJACENT ISLETS #23

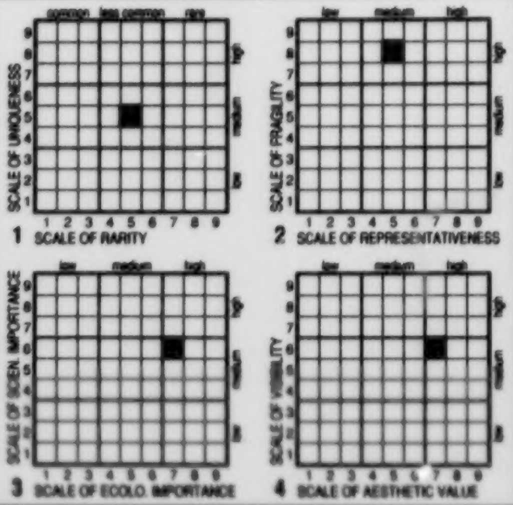


SEABIRD COLONY
HOSKINS ISLETS #24

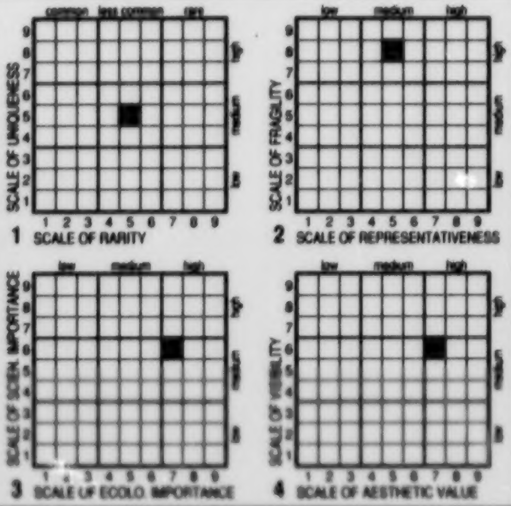


MARINE RESOURCE VALUE QUANTIFICATION SCALES

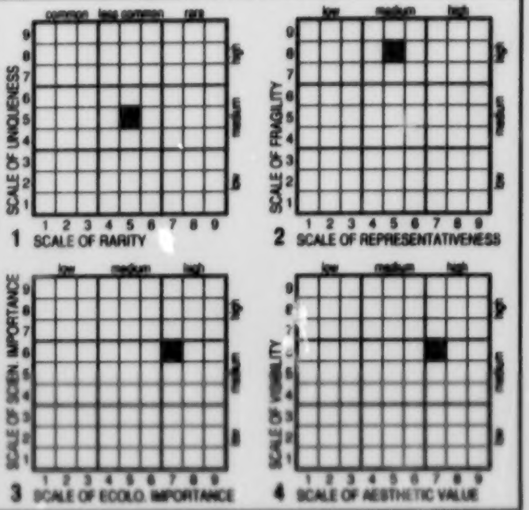
SEABIRD COLONY
BISCHOF ISLANDS #25



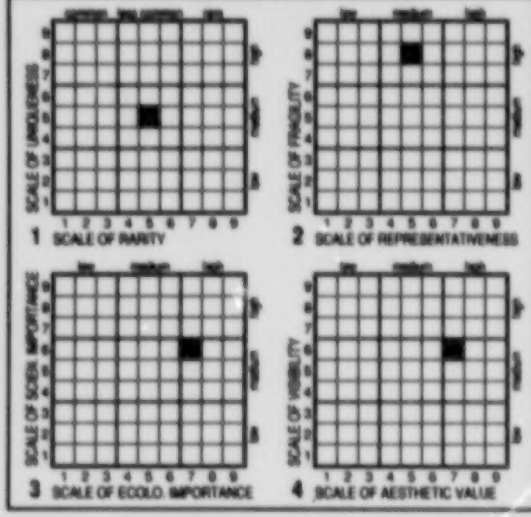
SEABIRD COLONY - UNNAMED
ISLAND IN SHUTTLE PASSAGE #26



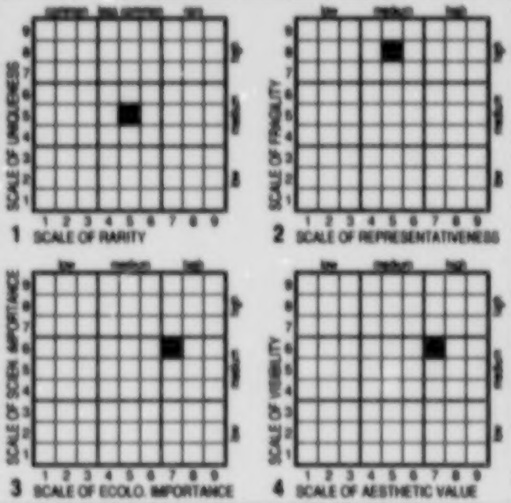
SEABIRD COLONY
GIL ISLET #27



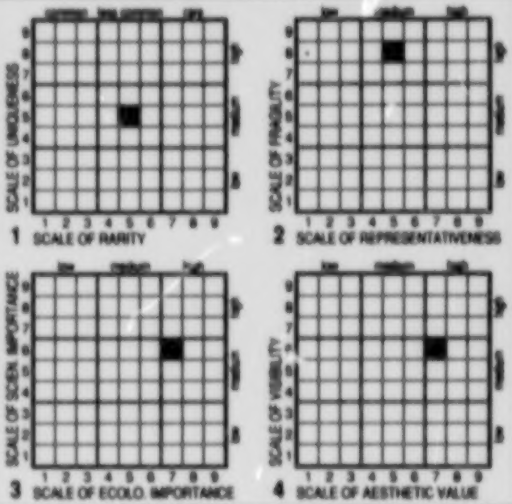
SEABIRD COLONY
RAINY ISLANDS #28



SEABIRD COLONY
GOODWIN POINT #29

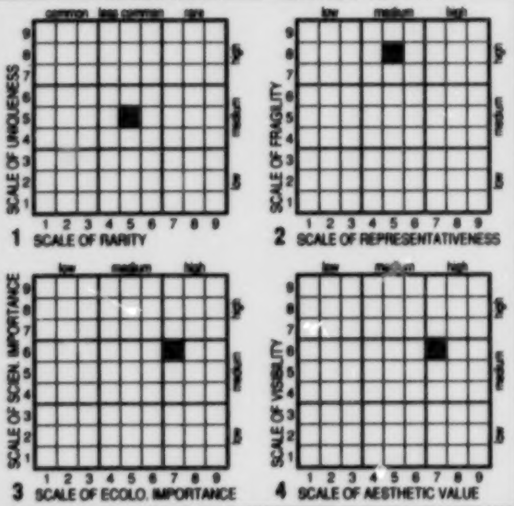


SEABIRD COLONY
NEST ISLETS #30

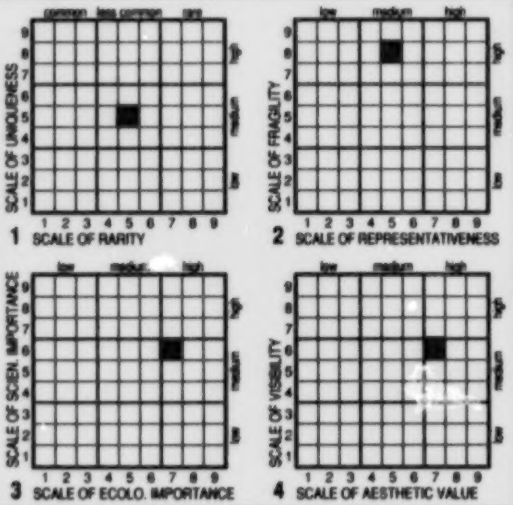


MARINE RESOURCE VALUE QUANTIFICATION SCALES

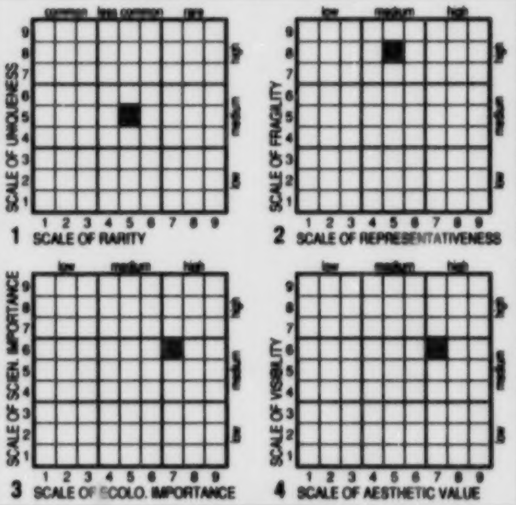
SEABIRD COLONY
INNER LOW ROCK #31



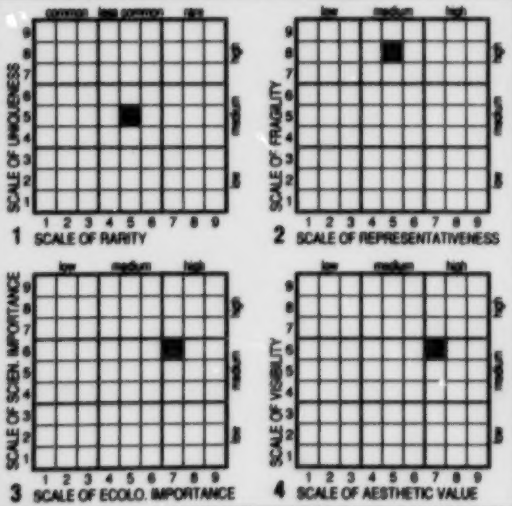
SEABIRD COLONY
GULL ISLET #32



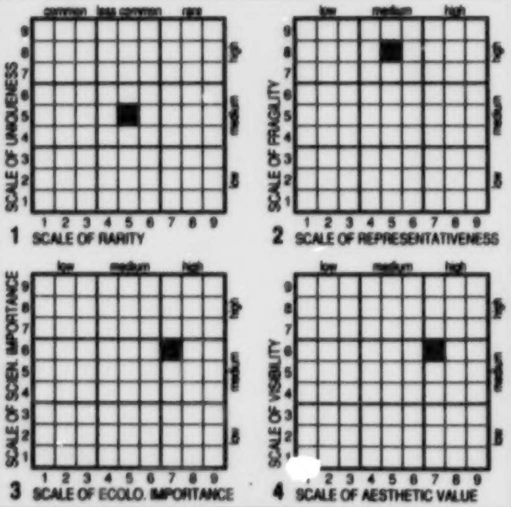
SEABIRD COLONY
LANGTRY ISLAND #33



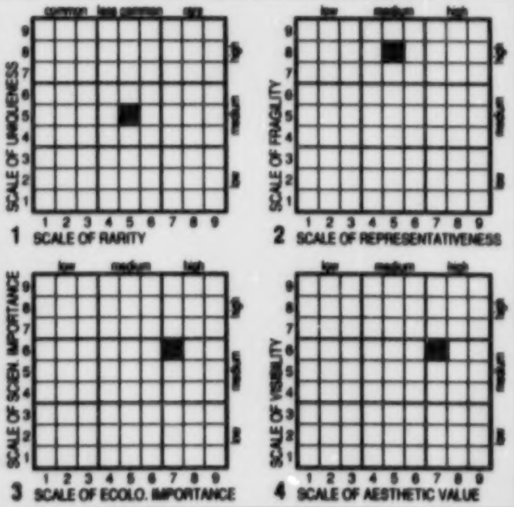
SEABIRD COLONY
ISLETS IN CARPENTER BAY #34



SEABIRD COLONY
HIGH ISLAND #35

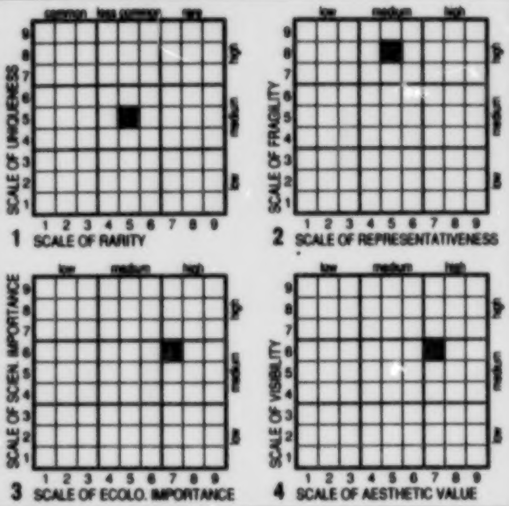


SEABIRD COLONY
HAYDON ROCK #36

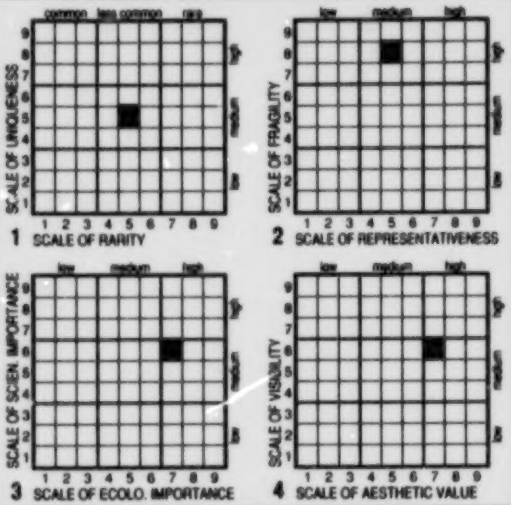


MARINE RESOURCE VALUE QUANTIFICATION SCALES

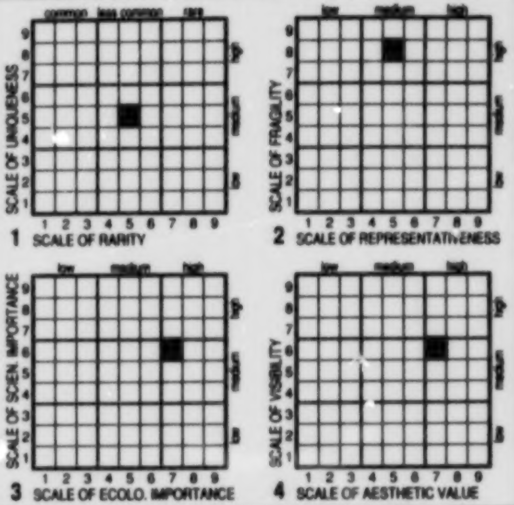
SEABIRD COLONY - ISLETS NW OF MOORE HEAD, KUNGHIT ISLAND #37



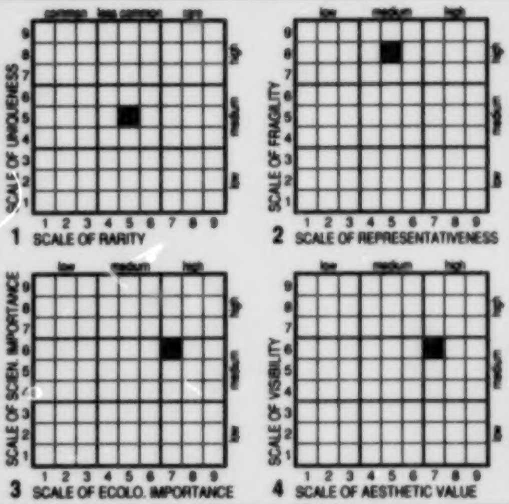
SEABIRD COLONY - NORTH SHORE OF ANNIS POINT PENINSULA #38



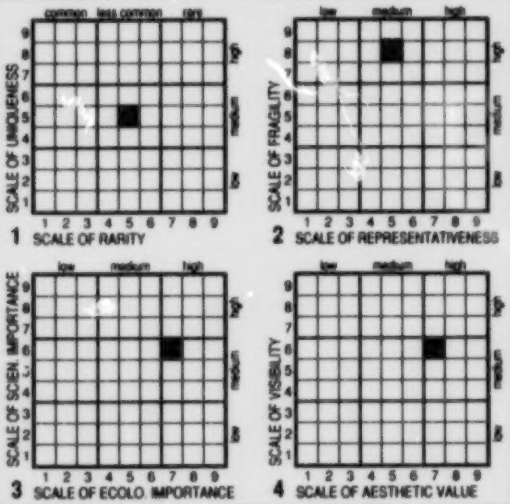
SEABIRD COLONY - ISLET IN BAY WEST OF LYMAN PT., KUNGHIT ISLAND #39



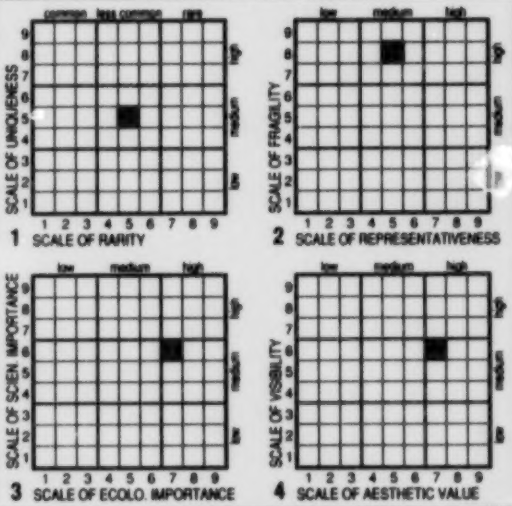
SEABIRD COLONY YADUS POINT, RAMSAY ISLAND #40



SEABIRD COLONY - ISLET NORTH OF ANDREW POINT, RAMSAY ISLAND #41

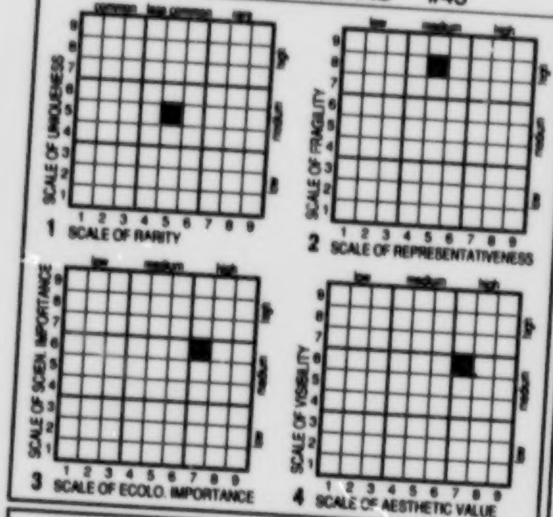


SEABIRD COLONY - SW OF HOTSPRINGS I. FROM MURCHISON I. TO RAMSAY PT. #42

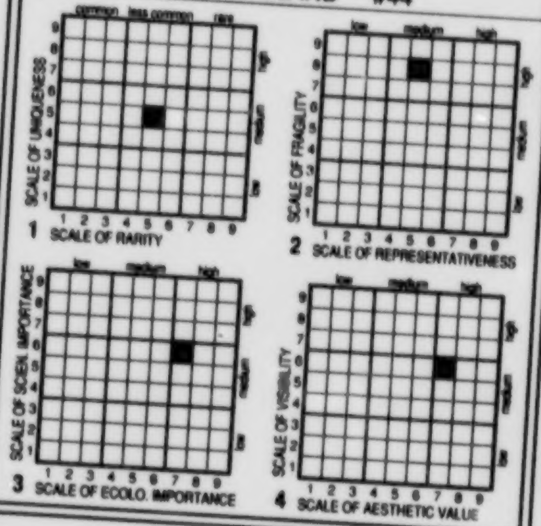


MARINE RESOURCE VALUE QUANTIFICATION SCALES

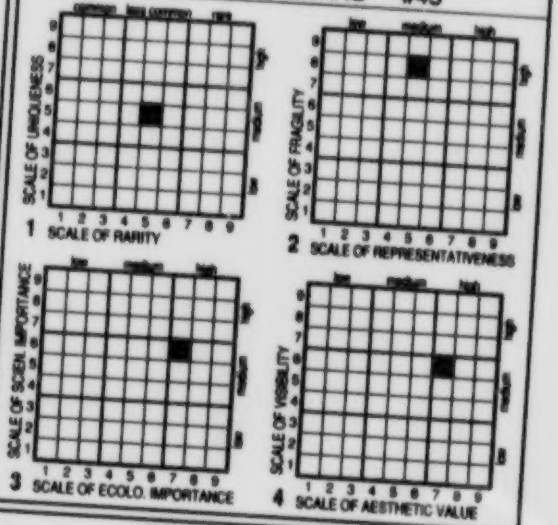
SEABIRD COLONY
HOTSPRINGS ISLAND #43



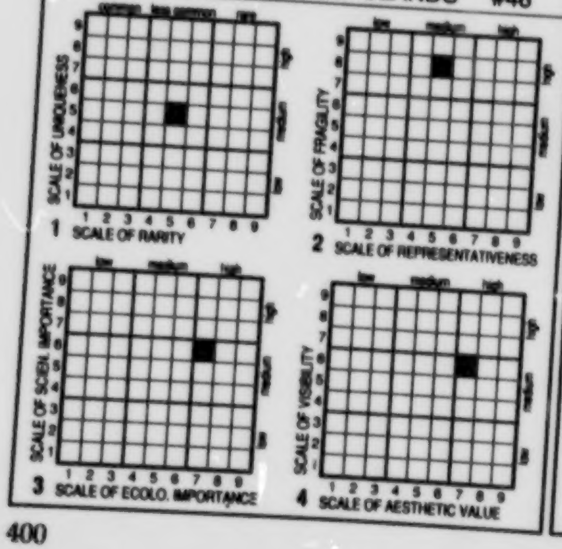
SEABIRD COLONY
HOUSE ISLAND #44



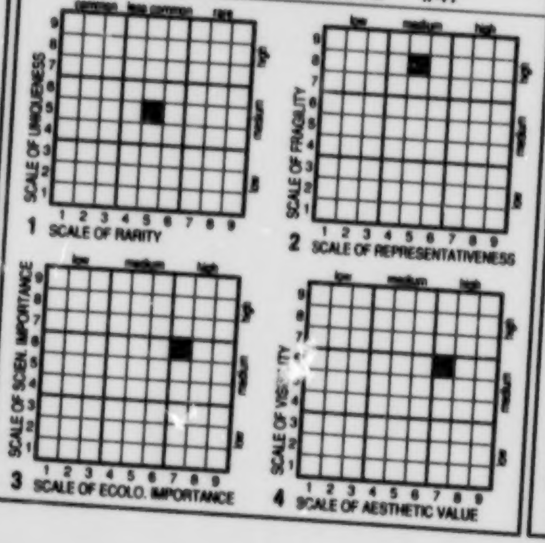
SEABIRD COLONY
MURCHISON ISLAND #45



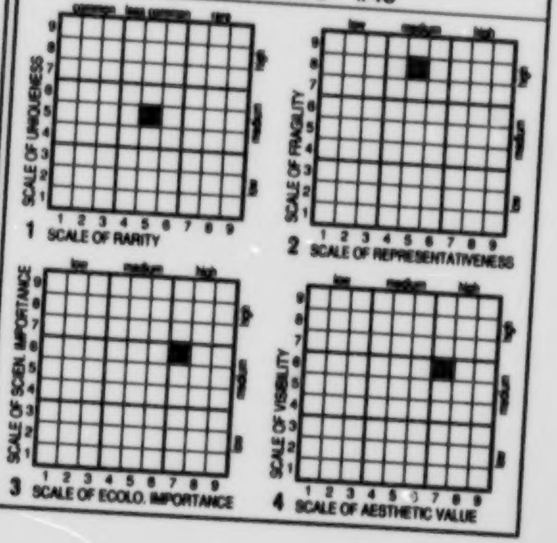
SEABIRD COLONY - ISLETS BETWEEN TAR & AGGLOMERATE ISLANDS #46



SEABIRD COLONY
AGGLOMERATE ISLAND #47

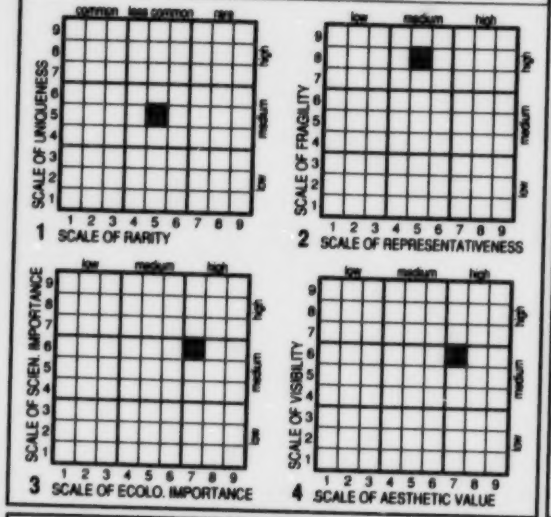


SEABIRD COLONY
TAR ISLANDS #48

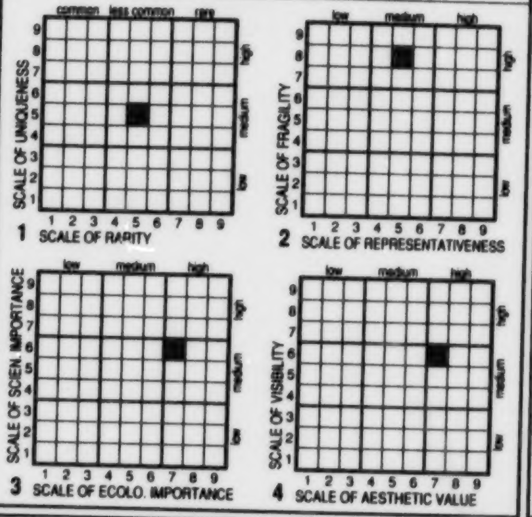


MARINE RESOURCE VALUE QUANTIFICATION SCALES

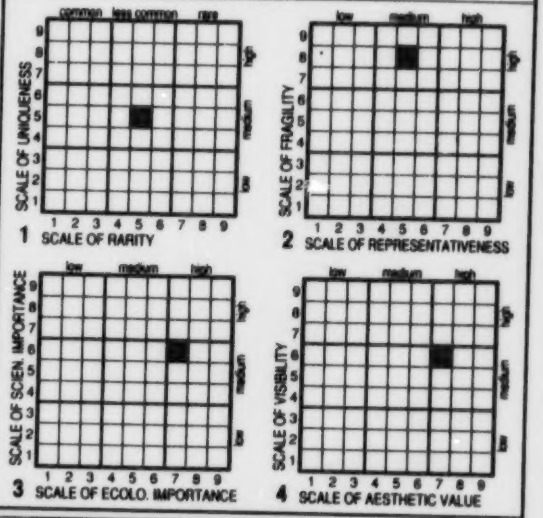
SEABIRD COLONY
TUFT ISLETS #49



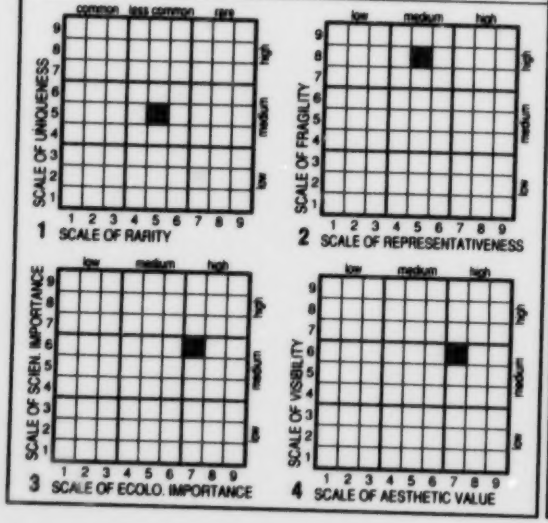
SEABIRD COLONY
FLATROCK ISLAND #50



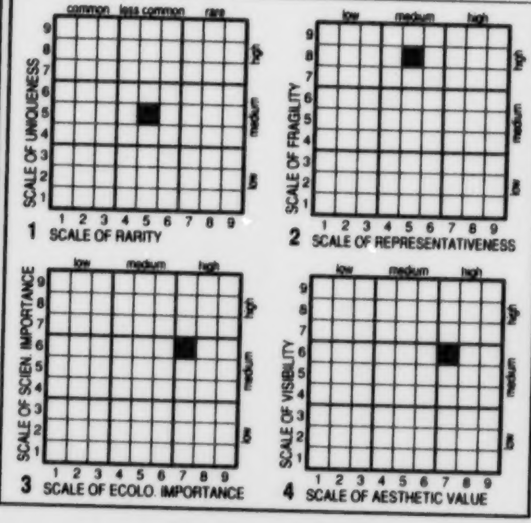
SEABIRD COLONY
TUGA POINT #51



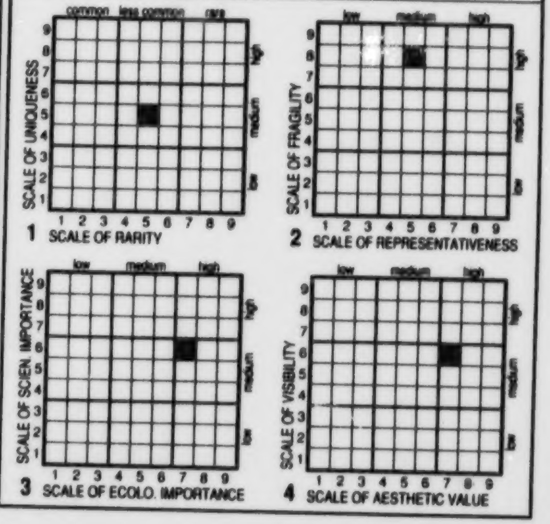
SEABIRD COLONY - ROCKY HEADLAND
NORTH OF McLEAN FRASER PT. #52



SEABIRD COLONY - ROCKY POINT W OF
LOWER VICTORIA LAKE ESTUARY #53

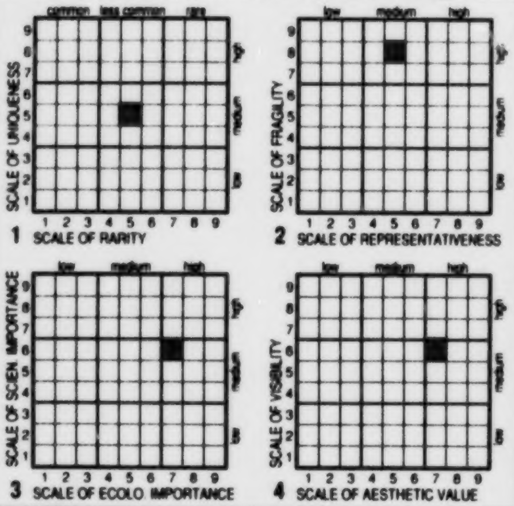


SEABIRD COLONY - ISLAND OFF UNNAMED
BAY SOUTH OF PUFFIN COVE #54

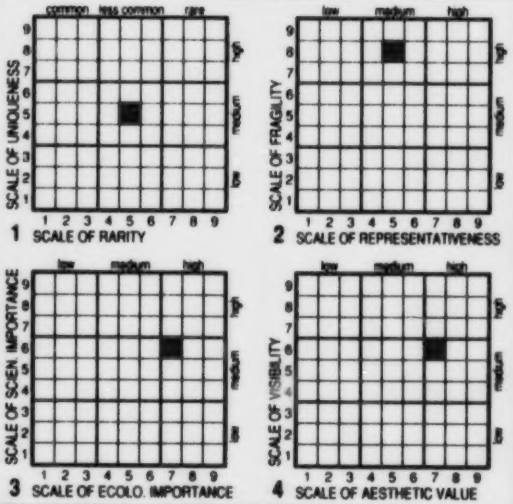


MARINE RESOURCE VALUE QUANTIFICATION SCALES

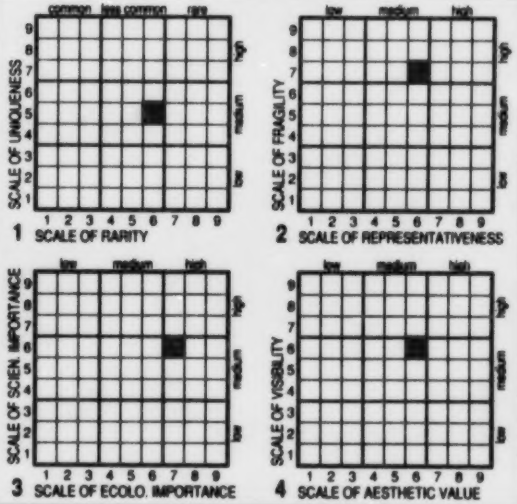
SEABIRD COLONY
ISLAND OFF PUFFIN COVE #55



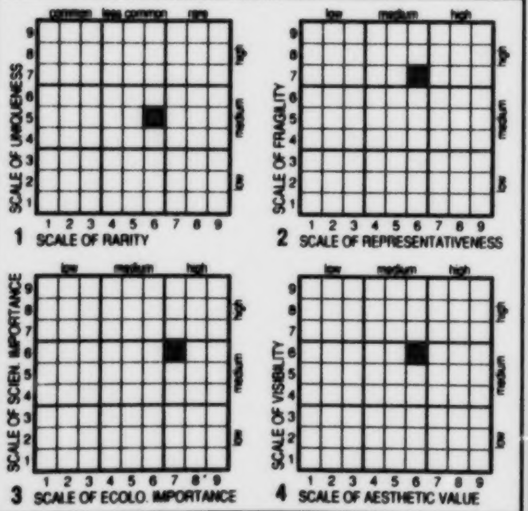
SEABIRD COLONIES
SOUTH POINT, MIKE INLET #56



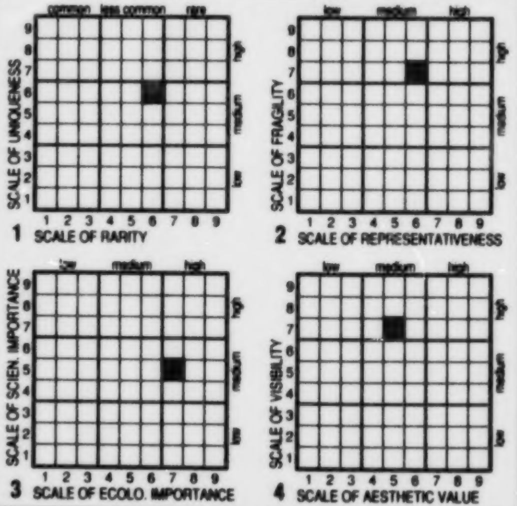
MARINE MAMMALS/SEABIRD COLONY
NEW ENGLAND & JOYCE ROCKS #57



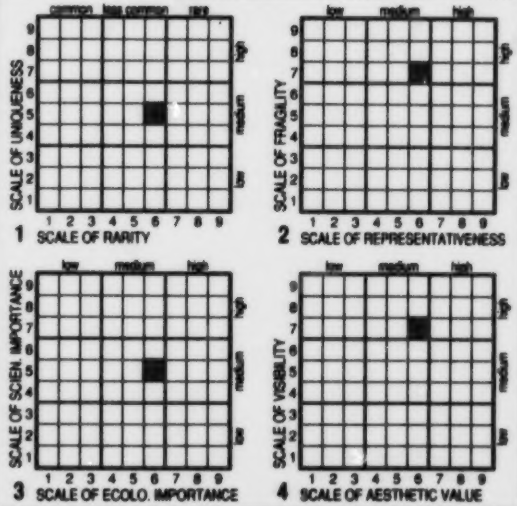
MARINE MAMMALS/SEABIRD COLONY
RANKINE ISLAND #58



SEA LIONS/SEABIRD COLONY
KEROUARD ISLANDS #59

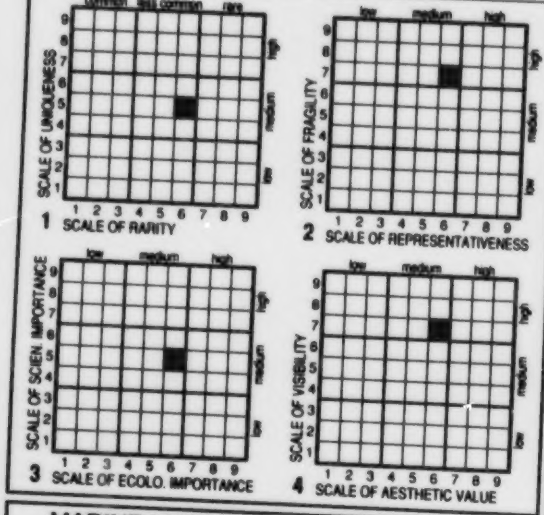


MARINE MAMMALS/SEABIRD COLONY
ANTHONY ISLAND #60

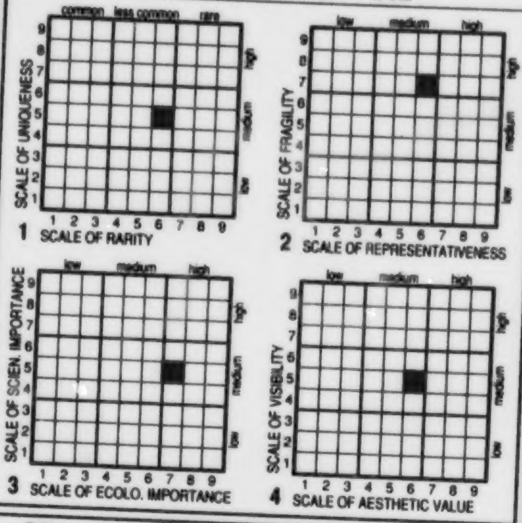


MARINE RESOURCE VALUE QUANTIFICATION SCALES

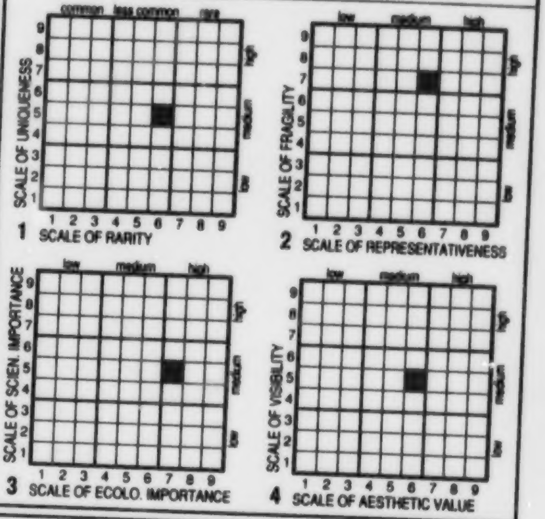
SEABIRD STAGING AREA SE OF ANTHONY ISLAND #61



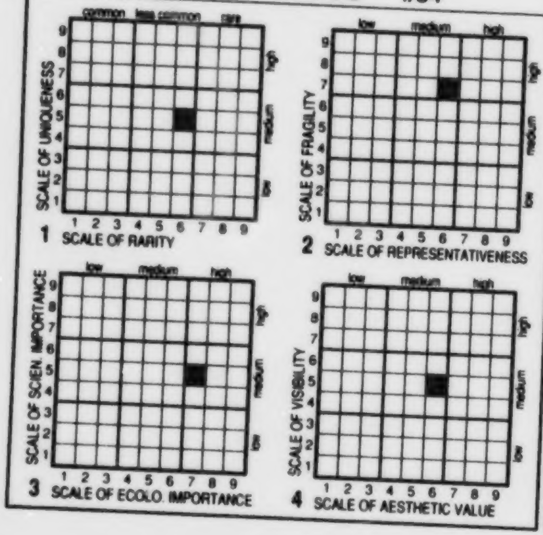
MARINE MAMMALS/SEABIRD COLONY BENJAMIN POINT #62



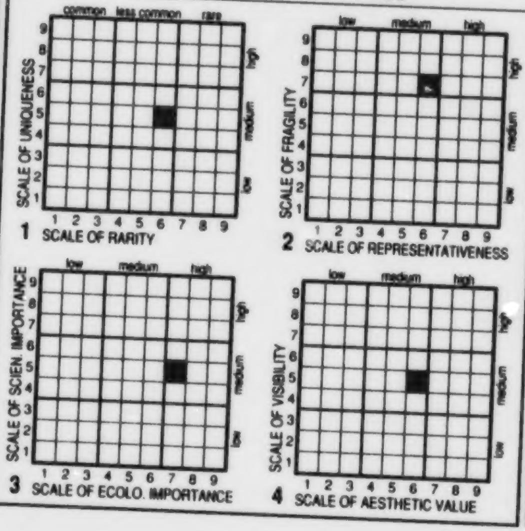
MARINE MAMMALS/SEABIRD COLONY GARCIN ROCKS #63



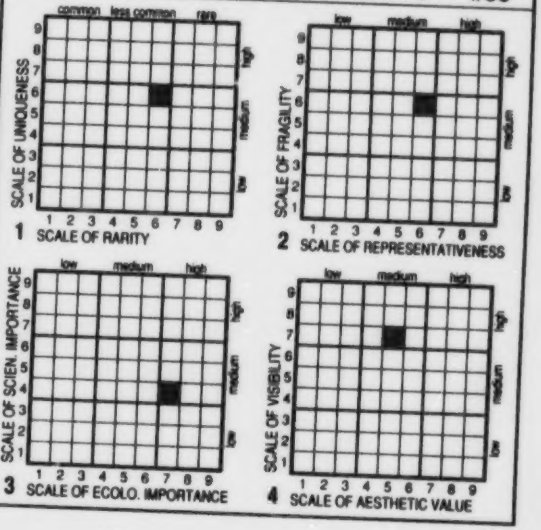
MARINE MAMMALS/SEABIRD COLONY GORDON ISLANDS #64



SEA LION HAULOUT/SEABIRD COLONY TATSUNG ROCK #65

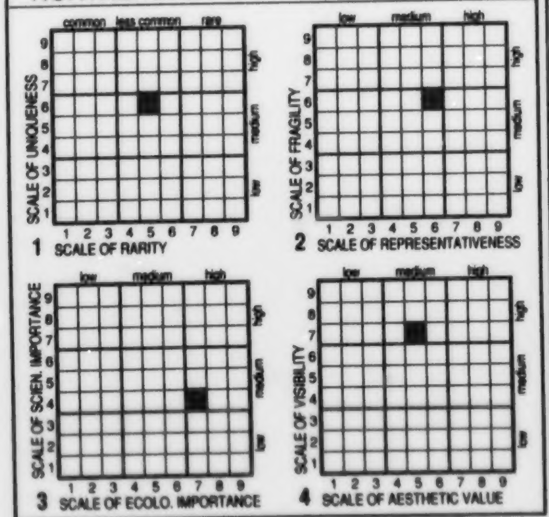


SEABIRD STAGING AREA - SURROUNDING ST. JAMES I. & KEROUARD ISLETS #66

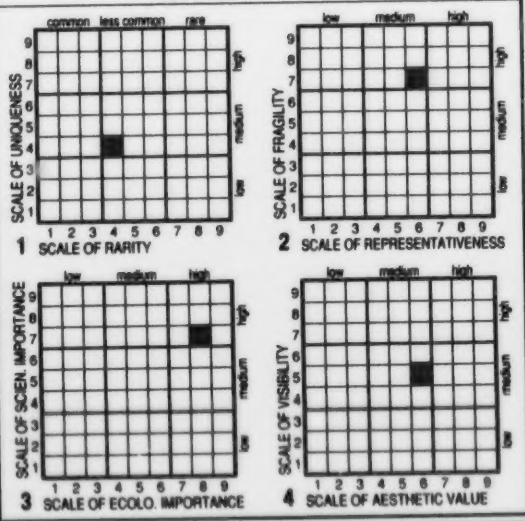


MARINE RESOURCE VALUE QUANTIFICATION SCALES

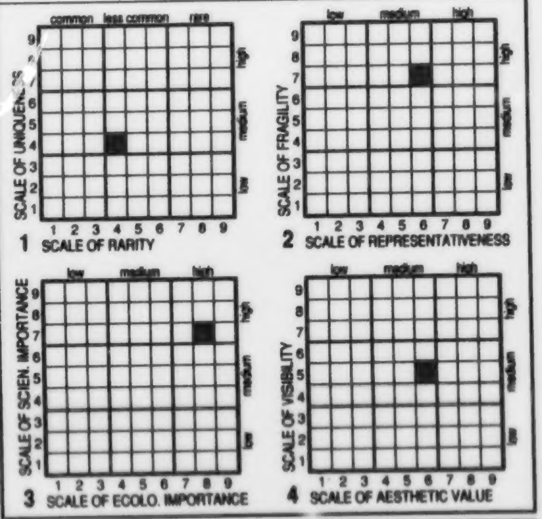
SEABIRD STAGING AREA
NORTHEAST OF COPPER ISLANDS #67



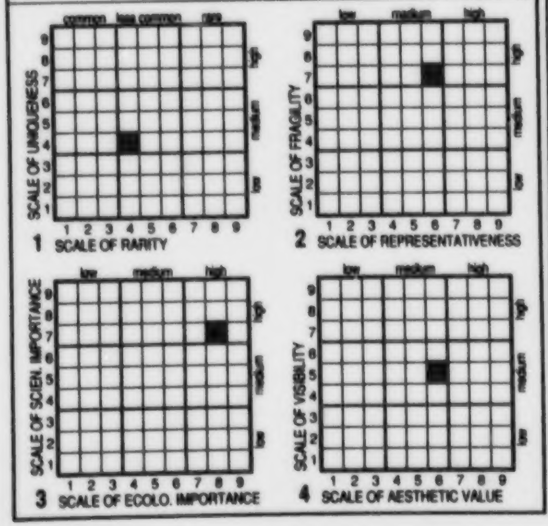
TIDAL FLAT/MARSH
ISLAND BAY #68



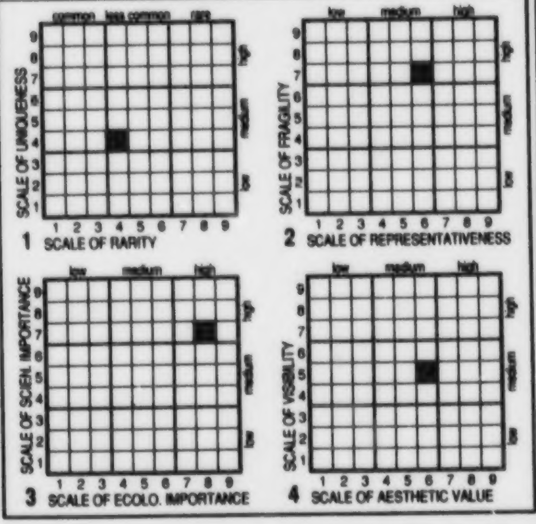
TIDAL FLAT/MARSH
GEORGE BAY #69



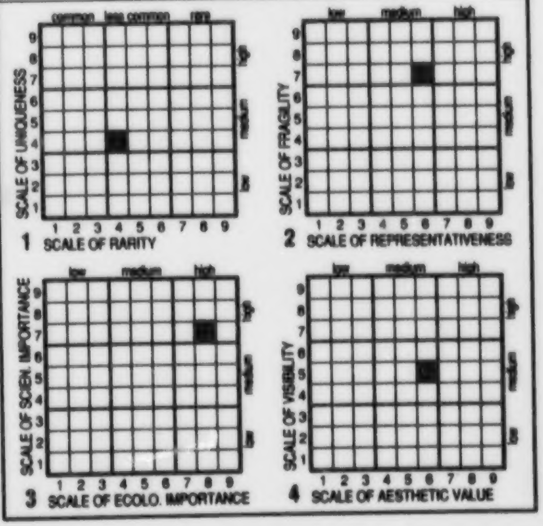
TIDAL FLAT/MARSH
SLIM INLET #70



TIDAL FLAT/MARSH
FLAMINGO INLET #71

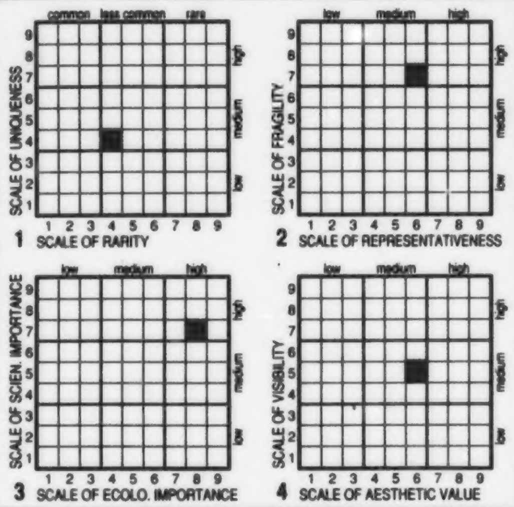


TIDAL FLAT/MARSH
LOUSCOONE INLET #72

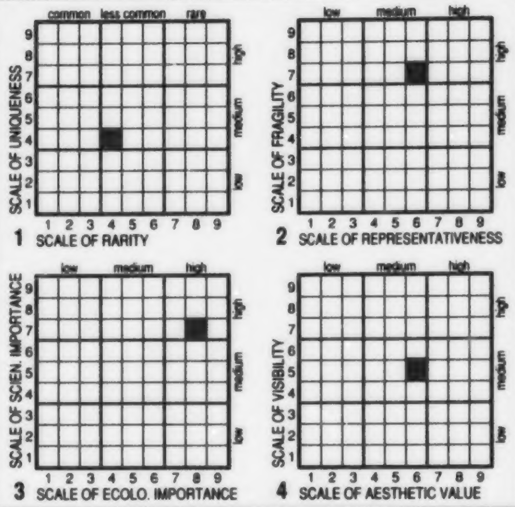


MARINE RESOURCE VALUE QUANTIFICATION SCALES

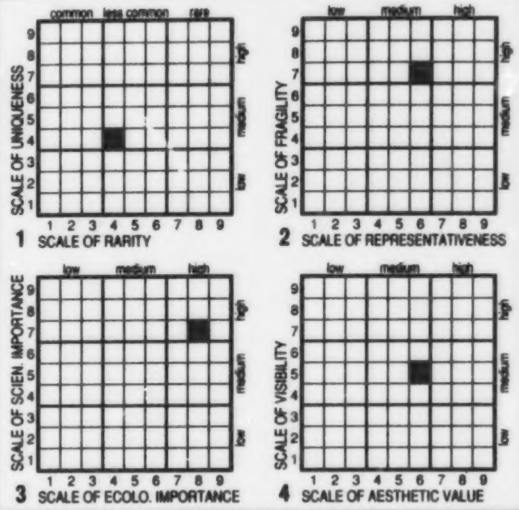
TIDAL FLAT/MARSH
CARPENTER BAY #73



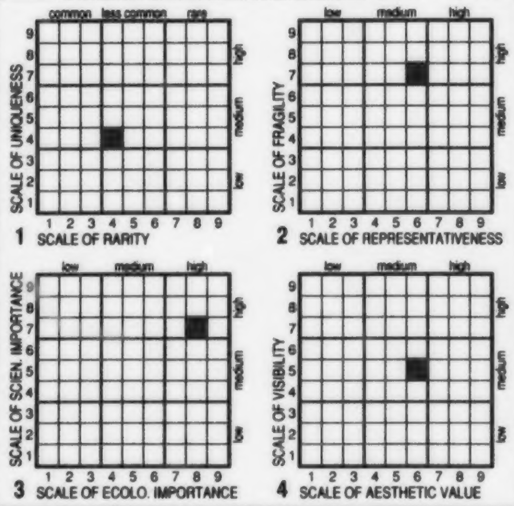
TIDAL FLAT/MARSH
ROSE INLET #74



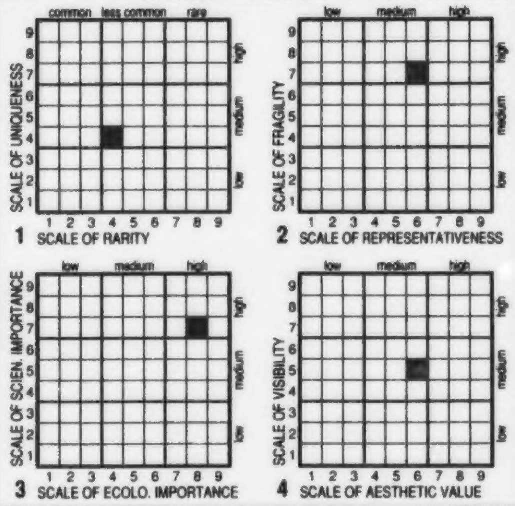
TIDAL FLAT/MARSH
BARRY INLET #75



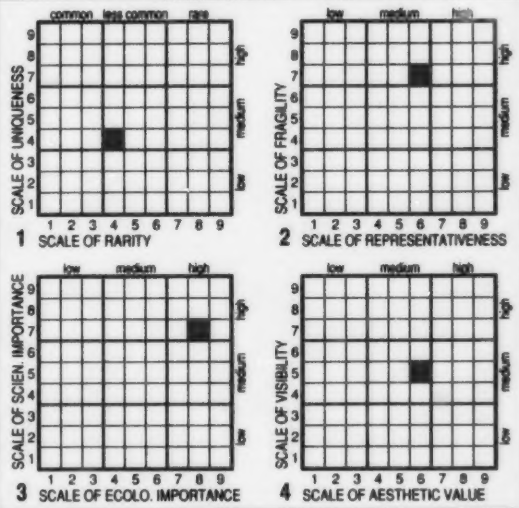
TIDAL FLAT/MARSH - BAY NORTH
OF GOGIT POINT #76



TIDAL FLAT/MARSH
SEDGEWICK BAY #77

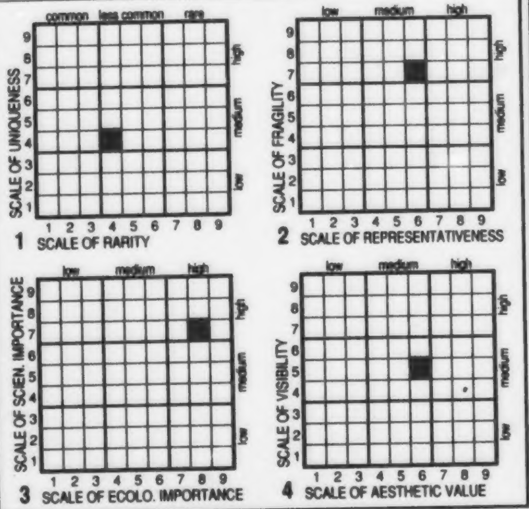


TIDAL FLAT/MARSH
ANNA INLET #78

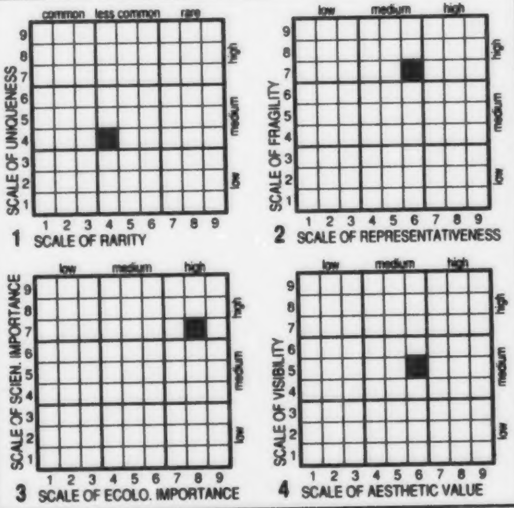


MARINE RESOURCE VALUE QUANTIFICATION SCALES

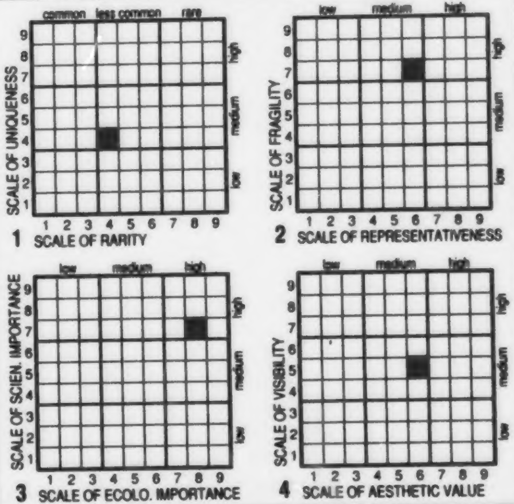
TIDAL FLAT/MARSH
McECHRAN COVE #79



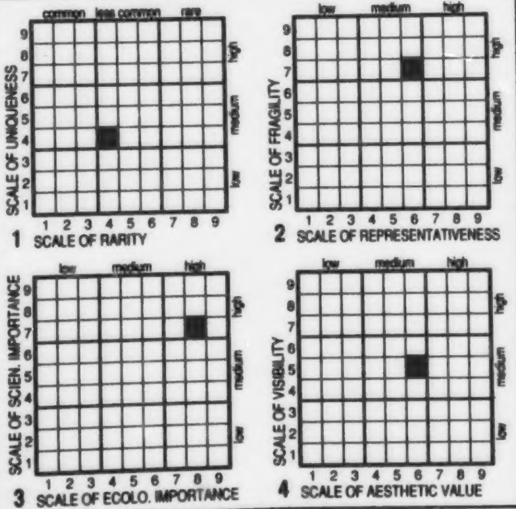
TIDAL FLAT/MARSH
LYELL BAY #80



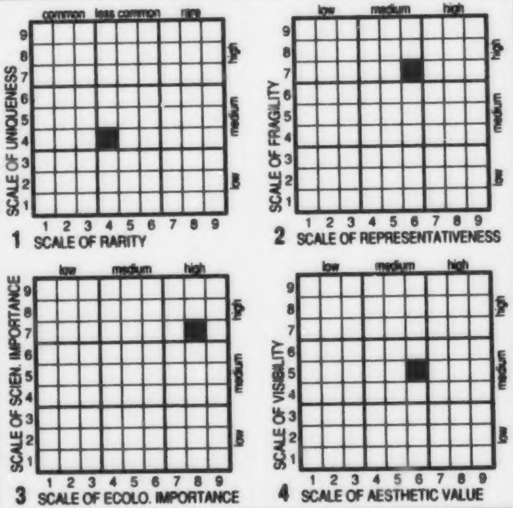
TIDAL FLAT/MARSH
KOSTAN INLET #81



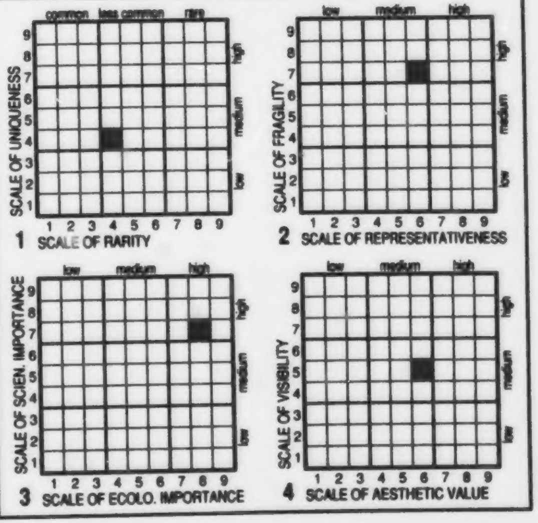
TIDAL FLAT/MARSH
DE LA BECHE INLET #82



TIDAL FLAT/MARSH
HASWELL BAY #83

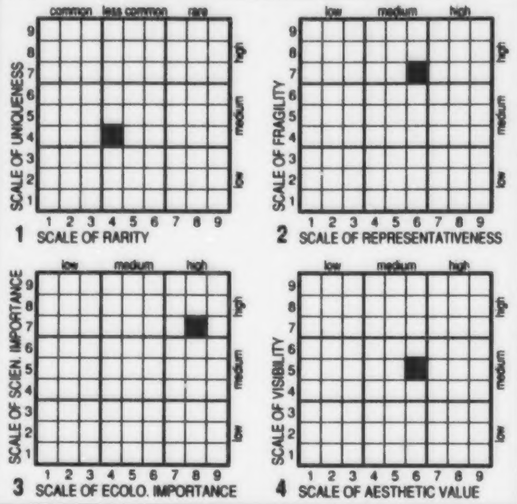


TIDAL FLAT/MARSH
HUTTON INLET #84

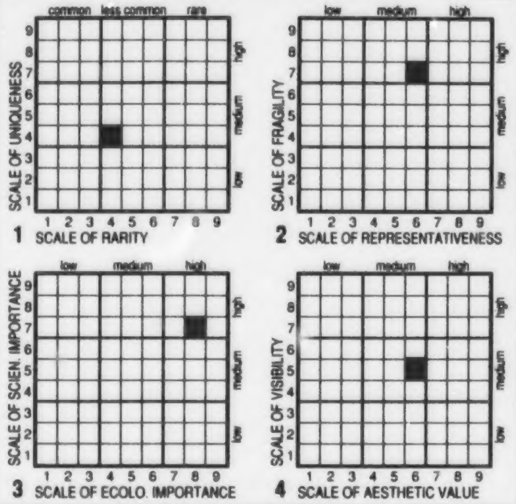


MARINE RESOURCE VALUE QUANTIFICATION SCALES

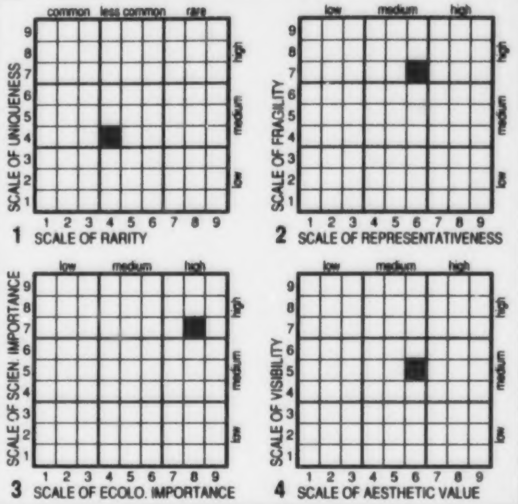
TIDAL FLAT/MARSH
MARSHALL INLET #85



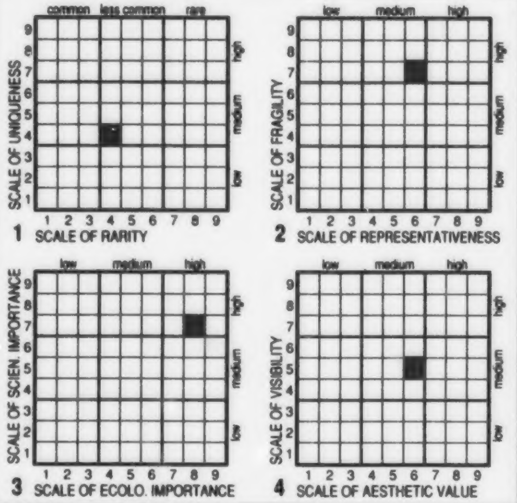
TIDAL FLAT/MARSH
MATHESON INLET #86



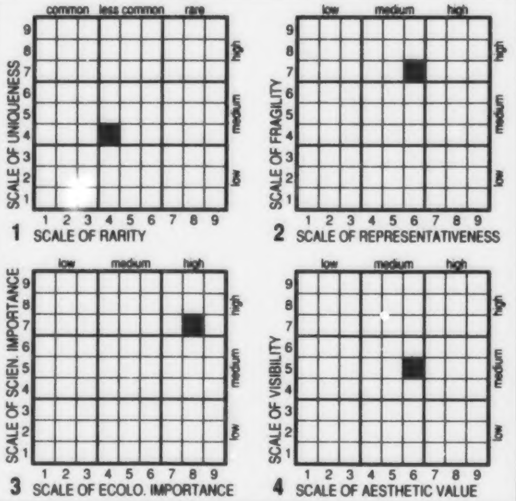
TIDAL FLAT/MARSH
ECHO HARBOUR #87



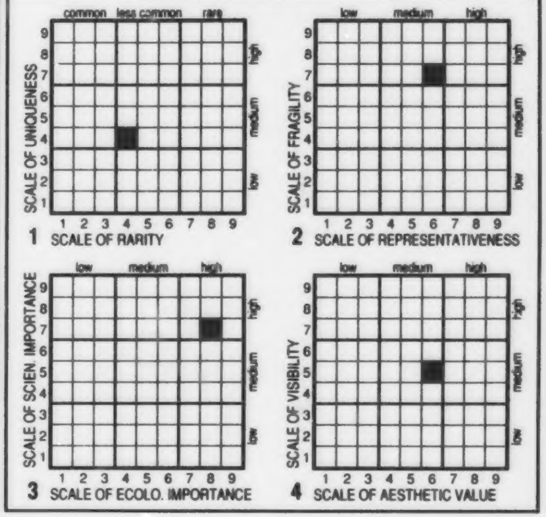
TIDAL FLAT/MARSH
BERESFORD INLET #88



TIDAL FLAT/MARSH
WINDY BAY #89

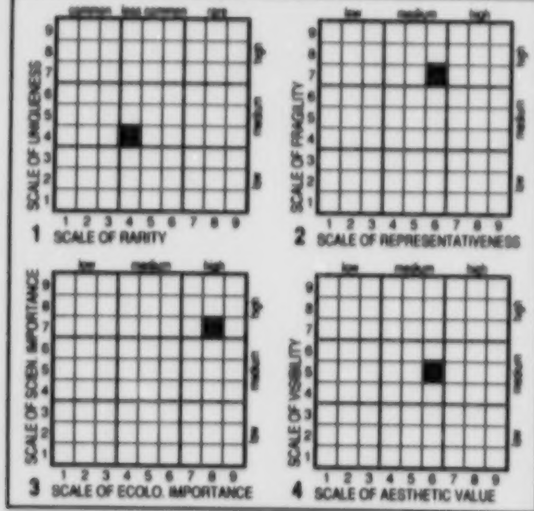


TIDAL FLAT/MARSH
POWRIVCO BAY #90

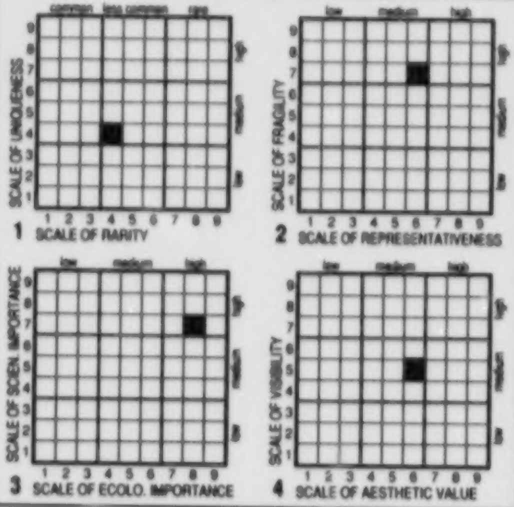


MARINE RESOURCE VALUE QUANTIFICATION SCALES

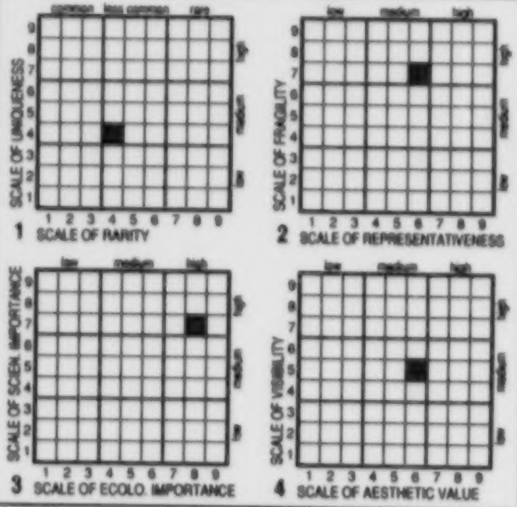
TIDAL FLAT/MARSH
BELJAY BAY #91



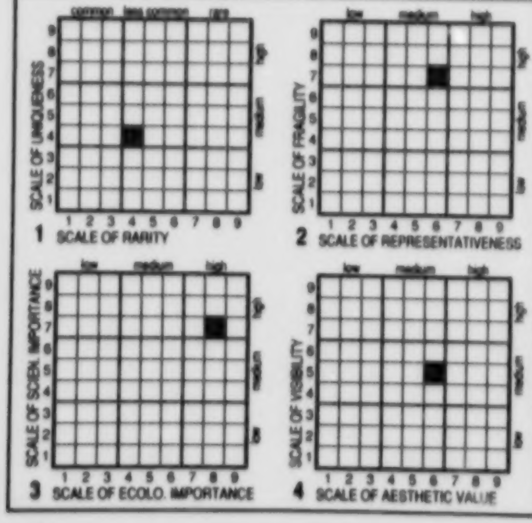
TIDAL FLAT/MARSH
TAKELLY COVE #92



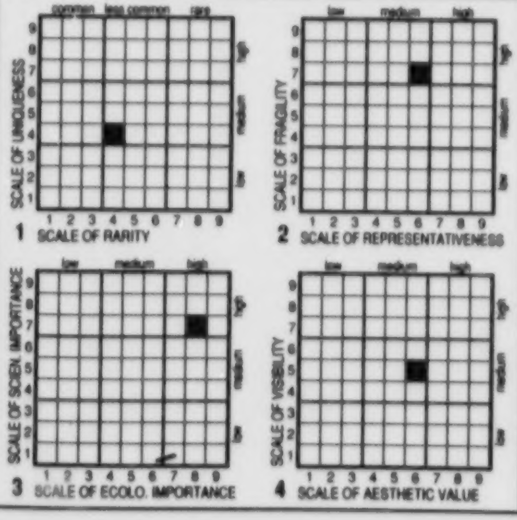
TIDAL FLAT/MARSH
GOSKI BAY #93



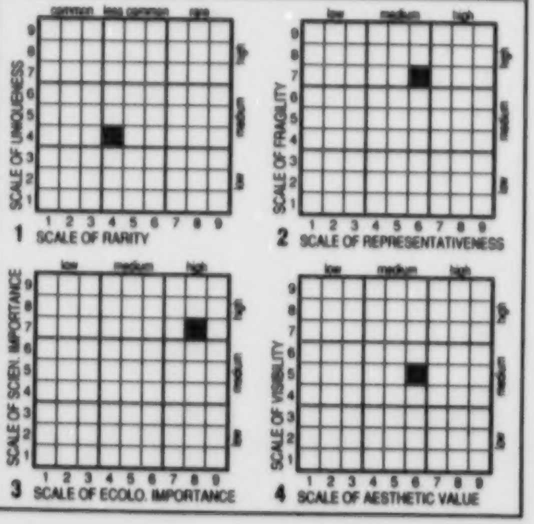
TIDAL FLAT/MARSH
YAKLANAS BAY #94



TIDAL FLAT/MARSH
LUXANA BAY #95

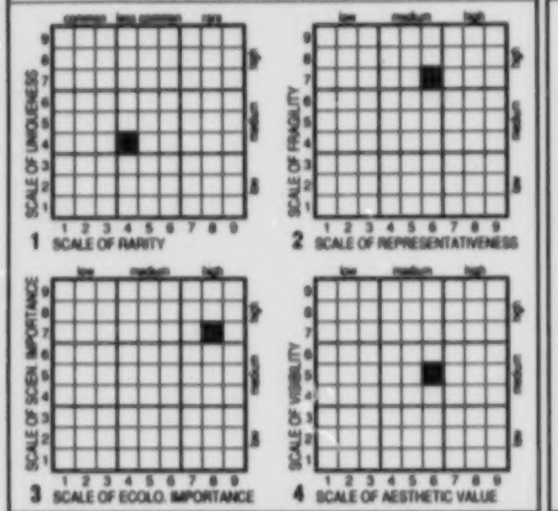


TIDAL FLAT/MARSH
HEATER HARBOUR #96

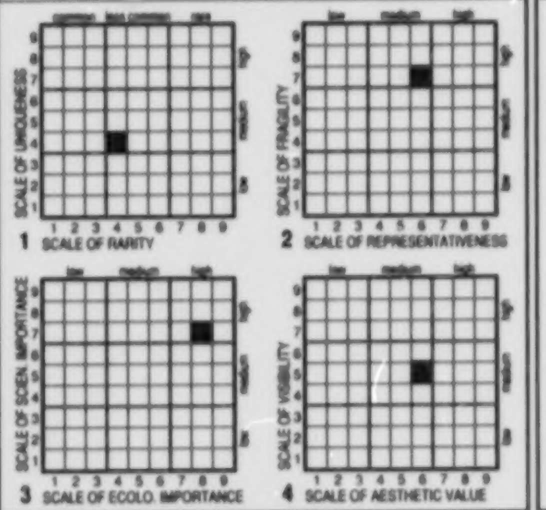


MARINE RESOURCE VALUE QUANTIFICATION SCALES

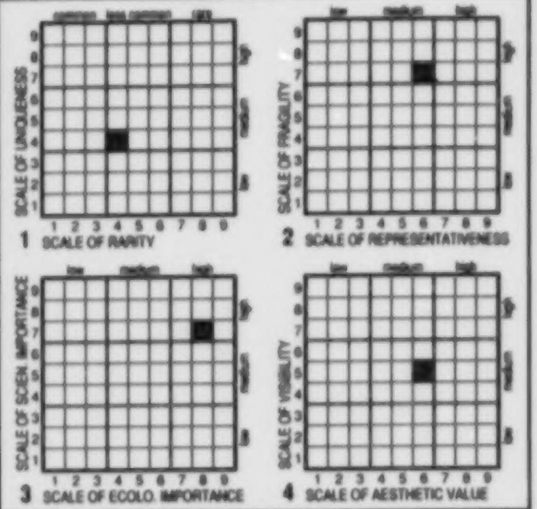
TIDAL FLAT/MARSH
HUSTON INLET #97



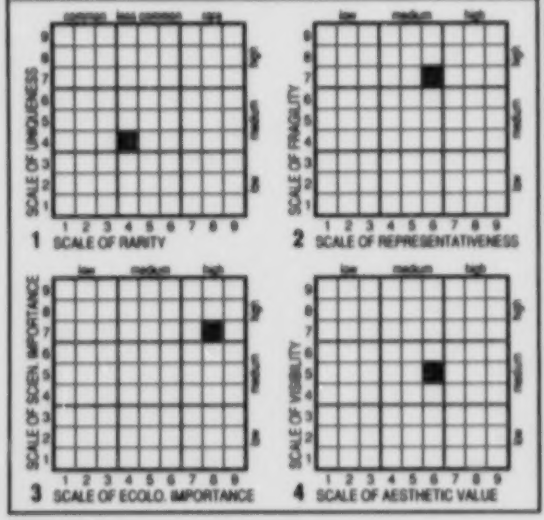
TIDAL FLAT/MARSH
HARRIET HARBOUR #98



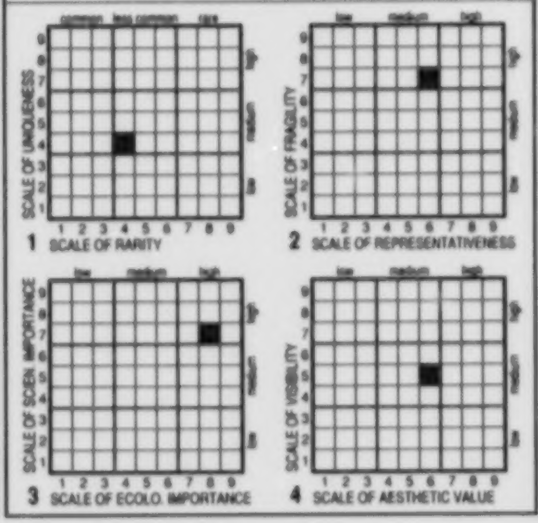
TIDAL FLAT/MARSH
IKEDA COVE #99



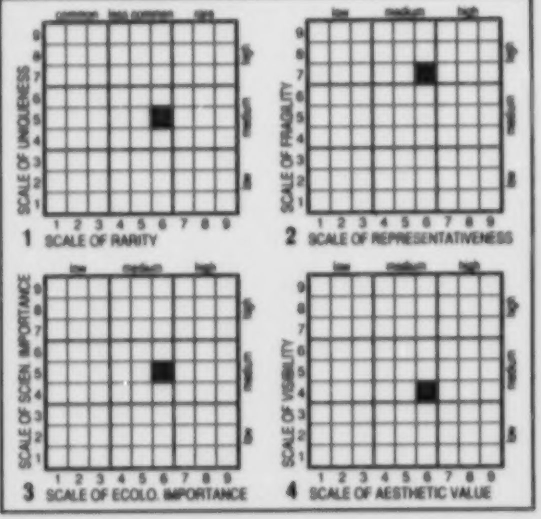
TIDAL FLAT/MARSH
BAG HARBOUR #100



TIDAL FLAT/MARSH
SKAAT HARBOUR #101

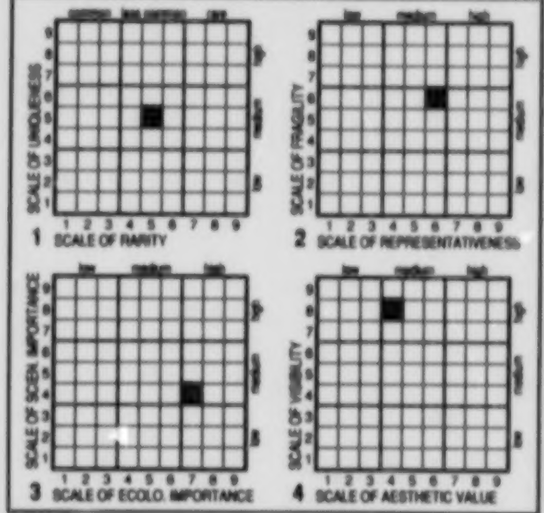


MARINE MAMMALS/SEABIRD COLONY
GOWDAS ROCKS #102

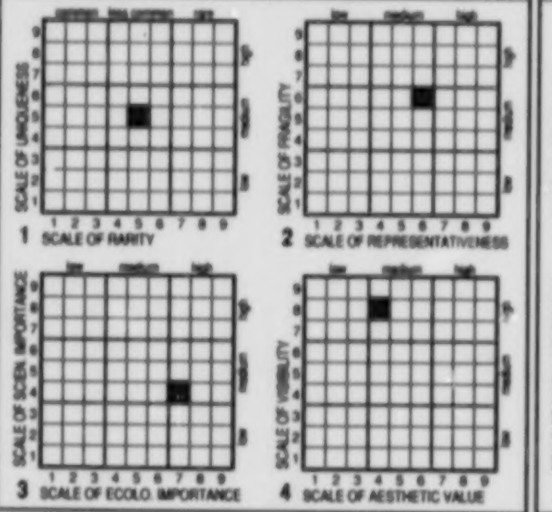


MARINE RESOURCE VALUE QUANTIFICATION SCALES

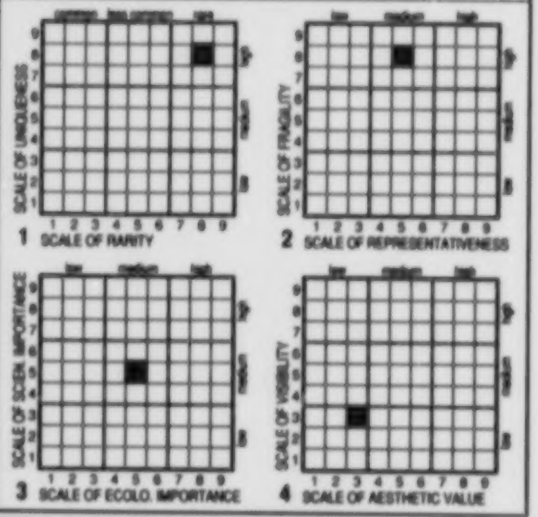
SEABIRD STAGING AREA - EAST OF LYMAN POINT, KUNGHIT ISLAND #103



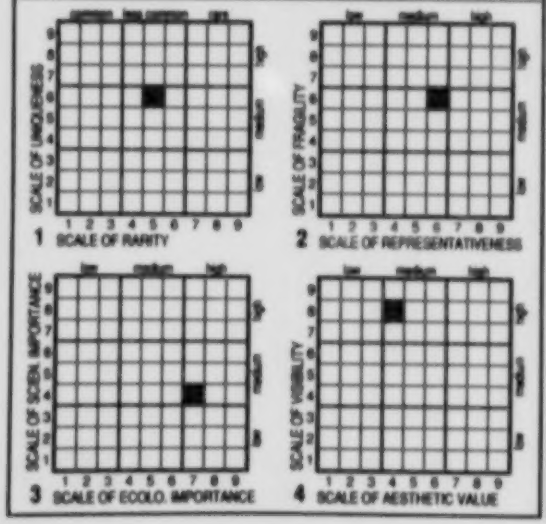
SEABIRD STAGING AREA SOUTH OF BOLKUS ISLANDS #104



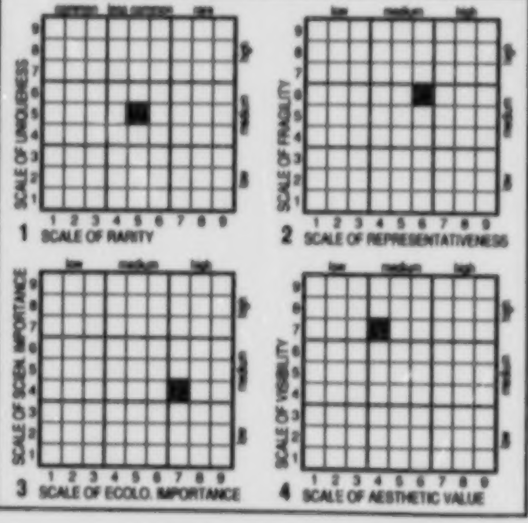
SEABIRD STAGING AREA - WEST & SOUTH OF RAMSEY & HOUSE ISLANDS #105



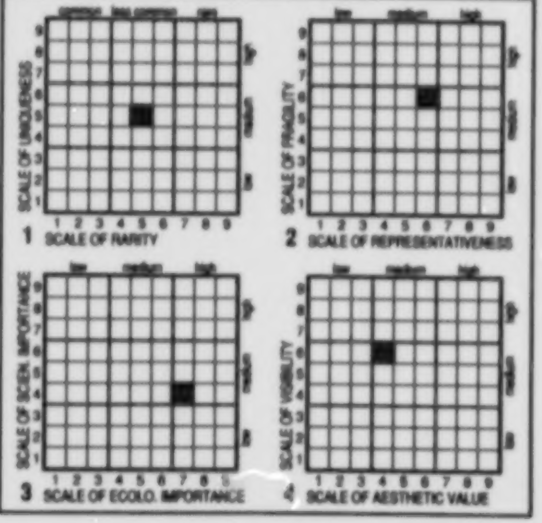
SEABIRD STAGING AREA - EAST OF DODGE POINT, LYELL ISLAND #106



SEABIRD STAGING AREA EAST OF RANKINE ISLANDS #107

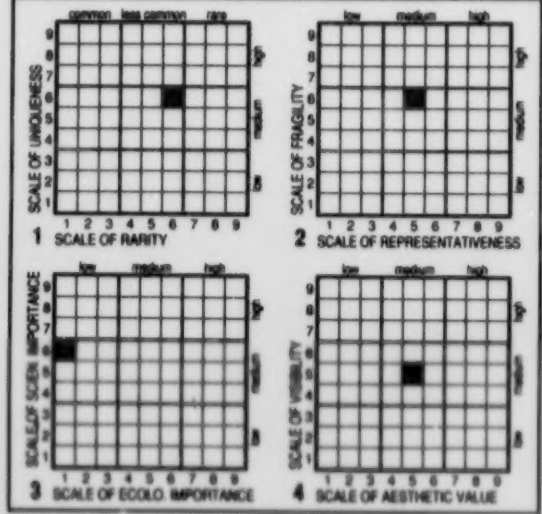


SEABIRD STAGING AREA NORTH OF ALDER ISLAND #108

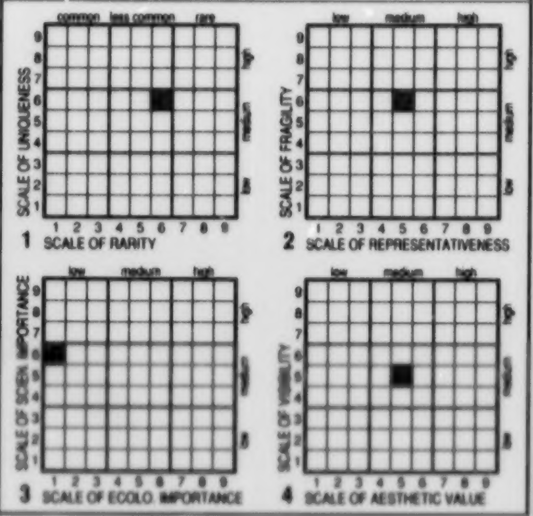


MARINE RESOURCE VALUE QUANTIFICATION SCALES

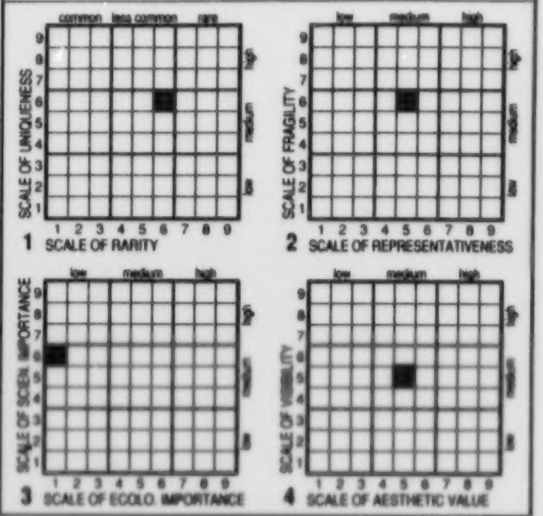
ARCHAEOLOGICAL SITE - NORTH OF ETCHES POINT, LOUSCOONE INLET #109



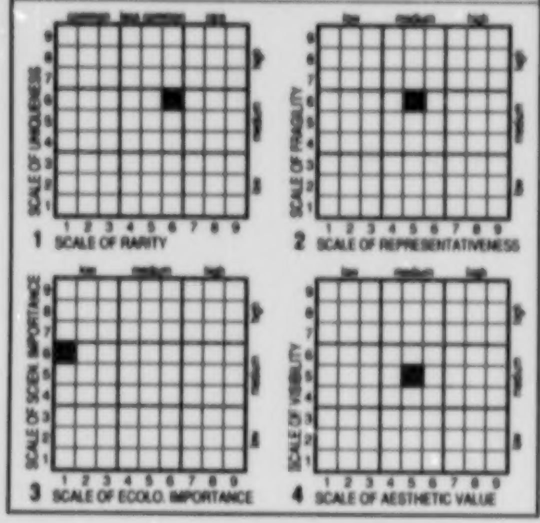
ARCHAEOLOGICAL SITE HEATER HARBOUR #110



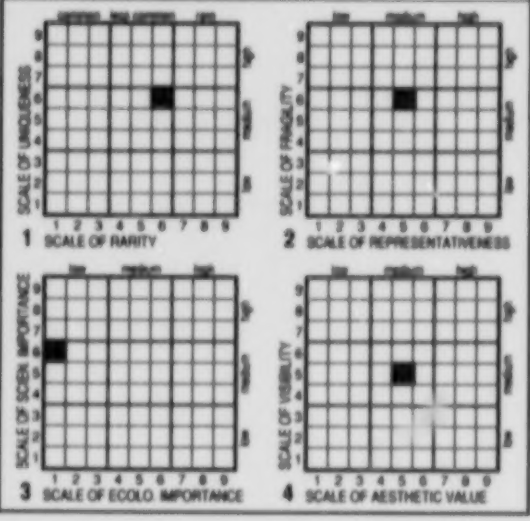
ARCHAEOLOGICAL SITE ROSS ISLAND #111



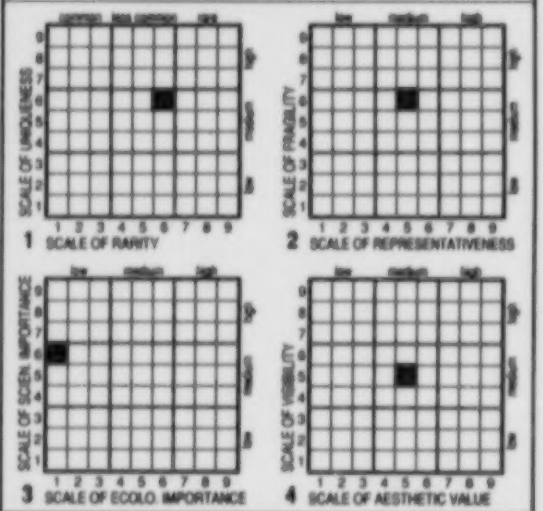
ARCHAEOLOGICAL SITE HUSTON INLET #112



ARCHAEOLOGICAL SITE SLIM INLET #113

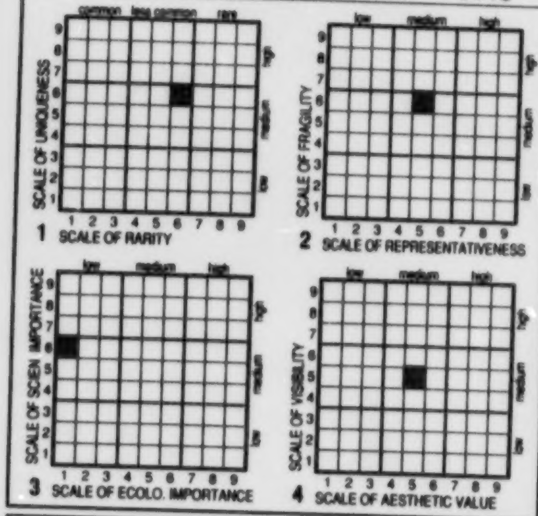


ARCHAEOLOGICAL SITE BAG HARBOUR #114

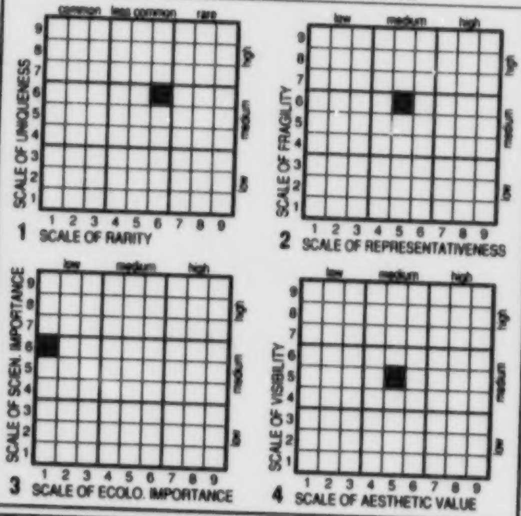


MARINE RESOURCE VALUE QUANTIFICATION SCALES

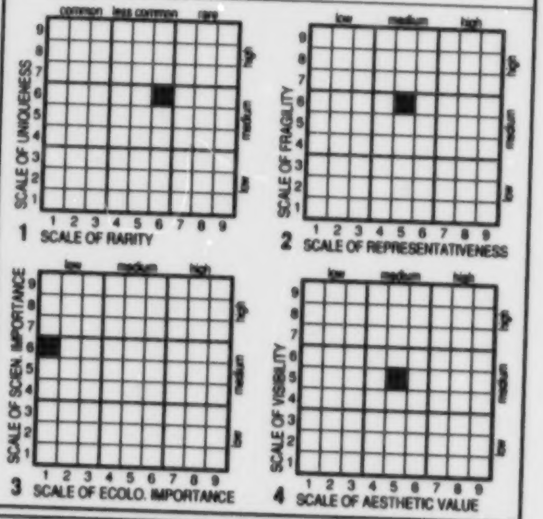
ARCHAEOLOGICAL SITE - NEAR DOLOMITE POINT, ISLAND BAY #115



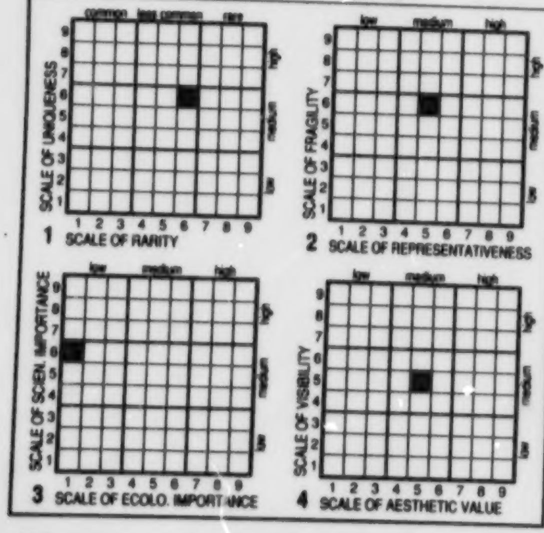
ARCHAEOLOGICAL SITE MATHESON INLET #116



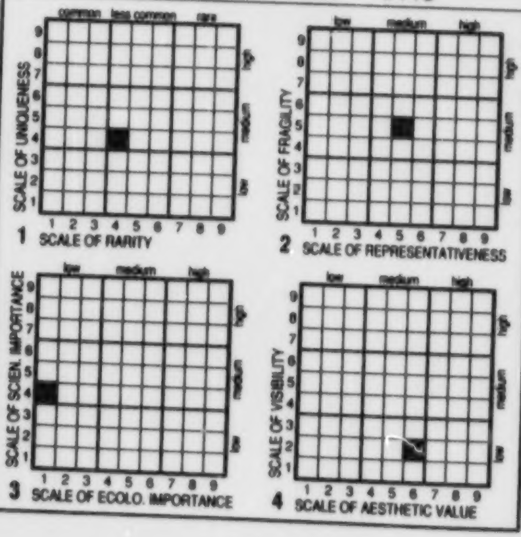
ARCHAEOLOGICAL SITE HUTTON INLET #117



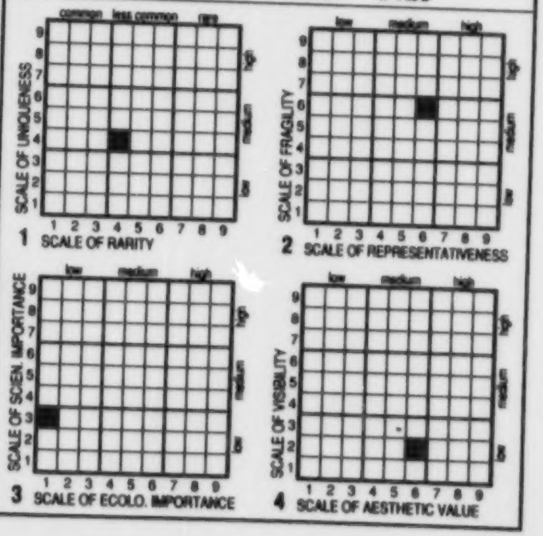
ARCHAEOLOGICAL SITE LYELL BAY #118



WRECK OF THE SEAGULL (1889) OFF CAPE ST. JAMES #119

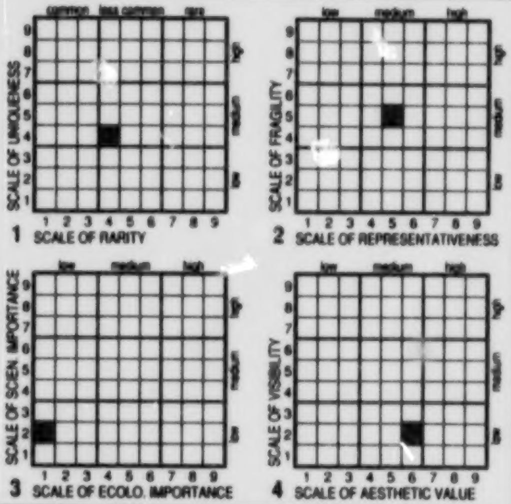


WRECK OF THE LARK (1786) OFF PORTER HEAD #120

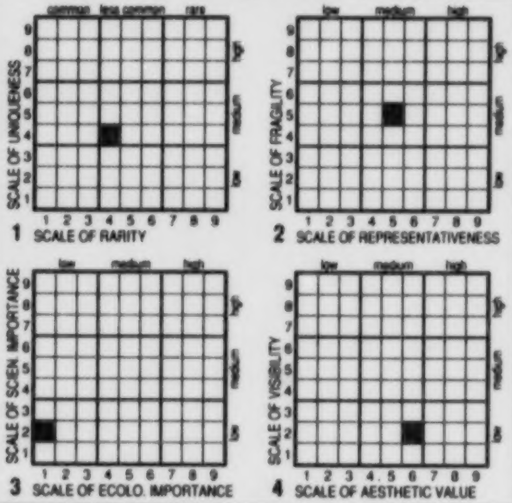


MARINE RESOURCE VALUE QUANTIFICATION SCALES

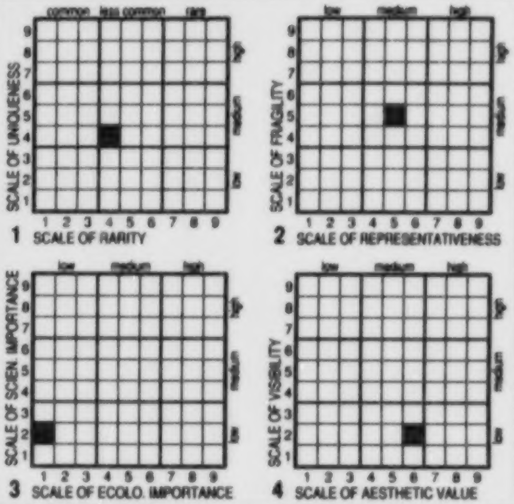
WRECK OF THE SAN THOMAS (1958)
OFF CAPE ST. JAMES #121



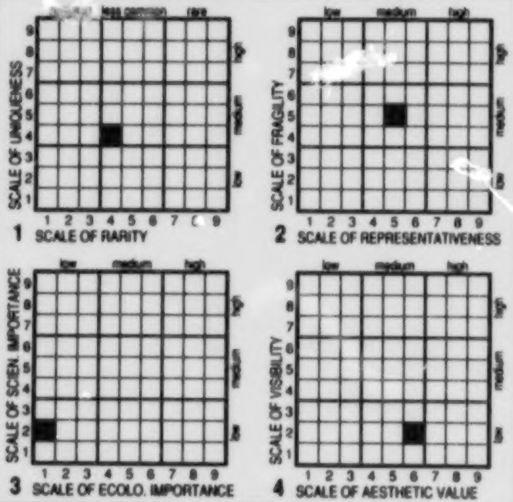
WRECK OF THE SCRUB (1950)
OFF COPPER ISLANDS #122



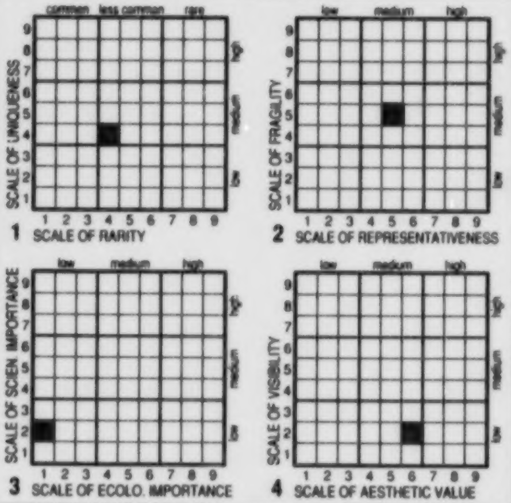
WRECK OF THE SUPERIOR (1948)
OFF TASU SOUND #123



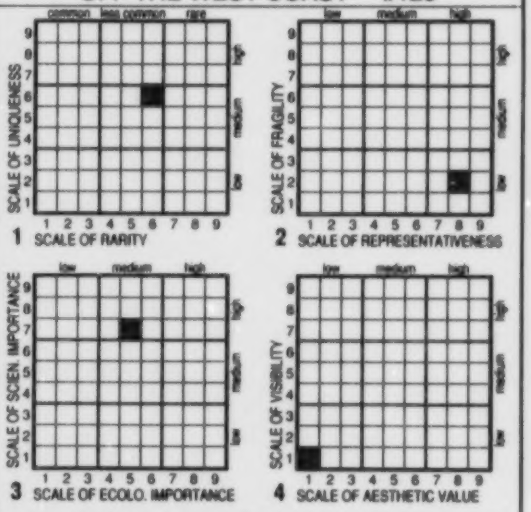
WRECK OF THE THELMA G. (1930)
OFF CAPE ST. JAMES #124



WRECK OF THE GALIANO (1918)
OFF CAPE ST. JAMES #125

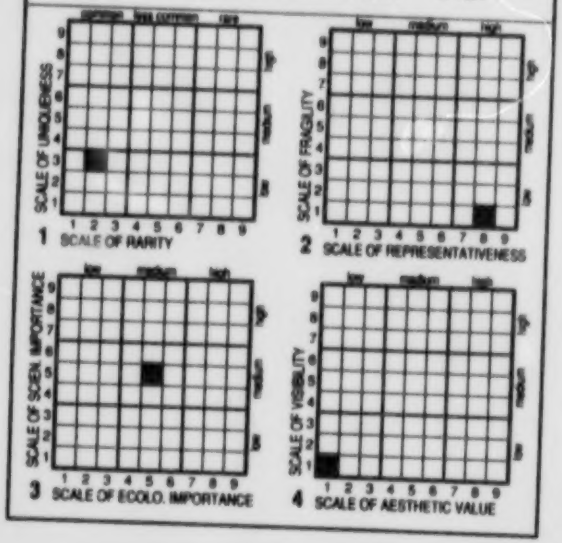


QUEEN CHARLOTTE FAULT
OFF THE WEST COAST #126



MARINE RESOURCE VQS

LOUSCOONE INLET FAULT #127



SUMMARY OF MARINE RESOURCE VALUE QUANTIFICATION SCALES

Number		Uniqueness	$\frac{1}{X}$	Rarity	$\frac{1}{X}$	Fragility	$\frac{1}{X}$	Represent.	$\frac{1}{X}$	Scient. Import.	$\frac{1}{X}$	Ecol. Import.	$\frac{1}{X}$	Visibility	$\frac{1}{X}$	Aesthetic Value	$\frac{1}{X}$	$\frac{1}{X}$ Total
1	Mammals/Seabirds, St. James Island	6	.166	8	.125	8	.125	9	.111	5	.200	9	.111	6	.166	8	.125	1.131
2	Queen Charlotte Fault	8	.125	6	.166	2	.500	8	.125	5	.200	5	.200	1	1.00	1	1.00	3.260
3	Marine Life, Faraday Island	5	.200	7	.143	8	.125	8	.125	8	.125	8	.125	5	.200	7	.143	1.319
4	Louscoone Inlet Fault	3	.333	2	.500	1	1.00	8	.125	5	.200	5	.200	1	1.00	1	1.00	4.358
5	Marine Life, Dolomite Narrows	6	.166	6	.166	8	.125	7	.143	6	.166	6	.166	7	.143	8	.125	1.204
6	Sea Lion Rafting, NW Burnaby Island	6	.166	7	.143	7	.143	7	.143	6	.166	7	.143	5	.200	6	.166	1.273
7	Mam./Seabirds, N. England & Joyce Rocks	5	.200	6	.166	7	.143	6	.166	5	.200	7	.143	6	.166	6	.166	1.354
8	Mammals/Seabirds, Rankine Island	5	.200	6	.166	7	.143	6	.166	5	.200	7	.143	6	.166	6	.166	1.354
9	Mam./Seabirds, Benjamin Point	5	.200	6	.166	7	.143	6	.166	5	.200	7	.143	5	.200	6	.166	1.387
10	Mammals/Seabirds, Garcin Rocks	5	.200	6	.166	7	.143	6	.166	5	.200	7	.143	5	.200	6	.166	1.387
11	Mammals/Seabirds, Gordon Island	5	.200	6	.166	7	.143	6	.166	5	.200	7	.143	5	.200	6	.166	1.387
12	Sea Lions/Seabirds, Tatsung Rock	5	.200	6	.166	7	.143	6	.166	5	.200	7	.143	5	.200	6	.166	1.387
13	Sea Lions/Seabirds, Kerouard Island	5	.200	6	.166	7	.143	6	.166	5	.200	7	.143	6	.166	6	.166	1.354
14	Mammals/Seabirds, Anthony Island	5	.200	6	.166	7	.143	6	.166	5	.200	7	.143	6	.166	6	.166	1.354
15	Sea Lions/Seabirds, Gowdas Rocks	5	.200	6	.166	7	.143	6	.166	5	.200	6	.166	4	.250	6	.166	1.461
16	Seabird Staging, St. James & Kerouard Is.	6	.166	6	.166	6	.166	6	.166	4	.250	7	.143	7	.143	5	.200	1.404
17	Seabird Staging, SE Anthony Island	6	.166	6	.166	6	.166	6	.166	4	.250	7	.143	8	.125	5	.200	1.386
18	Seabird Staging, E Kunghit Island	5	.200	5	.200	6	.166	6	.166	4	.250	7	.143	8	.125	4	.250	1.502
19	Seabird Staging, E Rankine Islands	5	.200	5	.200	6	.166	6	.166	4	.250	7	.143	7	.143	4	.250	1.520
20	Seabird Staging, S Bolkus Islands	5	.200	5	.200	6	.166	6	.166	4	.250	7	.143	8	.125	4	.250	1.502
21	Seabird Staging, NE Copper Islands	6	.166	5	.200	6	.166	6	.166	4	.250	7	.143	7	.143	5	.200	1.437
22	Seabird Staging, N Alder Island	5	.200	5	.200	6	.166	6	.166	4	.250	7	.143	6	.166	4	.250	1.544
23	Seabird Staging, W & S Ramsay & House Is.	5	.200	5	.200	6	.166	6	.166	4	.250	7	.143	7	.143	4	.250	1.520

SUMMARY OF MARINE RESOURCE VALUE QUANTIFICATION SCALES

Number		Uniqueness	$\frac{1}{X}$	Rarity	$\frac{1}{X}$	Fragility	$\frac{1}{X}$	Represent.	$\frac{1}{X}$	Scient. Import.	$\frac{1}{X}$	Ecol. Import.	$\frac{1}{X}$	Visibility	$\frac{1}{X}$	Aesthetic Value	$\frac{1}{X}$	$\frac{1}{X}$ Total
24	Seabird Staging, E of Dodge Point, Lyell I.	5	.167	5	.200	6	.167	6	.167	4	.250	7	.143	7	.143	4	.250	1.520
25	Wreck, San Thomas (1958), Porter Head	4	.200	5	.200	5	.200	5	.200	2	.500	1	1.00	2	.500	6	.167	3.067
26	Wreck, Scrub (1950), Copper Island	4	.200	5	.200	5	.200	5	.200	2	.500	1	1.00	2	.500	6	.167	3.067
27	Wreck, Superior (1948), Tasu Sound	4	.200	5	.200	5	.200	5	.200	2	.500	1	1.00	2	.500	6	.167	3.067
28	Wreck, Thelma G. (1930), Cape St. James	4	.200	5	.200	5	.200	5	.200	2	.500	1	1.00	2	.500	6	.167	3.067
29	Wreck, Galiano (1918), Cape St. James	4	.200	5	.200	5	.200	5	.200	2	.500	1	1.00	2	.500	6	.167	3.067
30	Wreck, Seagull (1889), Cape St. James	4	.200	5	.200	5	.200	5	.200	2	.333	1	1.00	2	.500	6	.167	2.900
31	Wreck, Lark (1786), Porter Head	4	.200	5	.200	5	.200	5	.200	3	.333	1	1.00	2	.500	6	.167	2.900
32	Arch. Site, N of Etches Pt., Louscoone Inlet	6	.167	6	.167	6	.167	5	.200	6	.167	1	1.00	5	.200	5	.200	2.268
33	Arch. Site, Heater Harbour	6	.167	6	.167	6	.167	5	.200	6	.167	1	1.00	5	.200	5	.200	2.268
34	Arch. Site, Ross Island	6	.167	6	.167	6	.167	5	.200	6	.167	1	1.00	5	.200	5	.200	2.268
35	Arch. Site, Huston Inlet	6	.167	6	.167	6	.167	5	.200	6	.167	1	1.00	5	.200	5	.200	2.268
36	Arch. Site, Slim Inlet	6	.167	6	.167	6	.167	5	.200	6	.167	1	1.00	5	.200	5	.200	2.268
37	Arch. Site, Bag Harbour	6	.167	6	.167	6	.167	5	.200	6	.167	1	1.00	5	.200	5	.200	2.268
38	Arch. Site, Dolomite Point, Island Bay	6	.167	6	.167	6	.167	5	.200	6	.167	1	1.00	5	.200	5	.200	2.268
39	Arch. Site, Matheson Inlet	6	.167	6	.167	6	.167	5	.200	6	.167	1	1.00	5	.200	5	.200	2.268
40	Arch. Site, Hutton Inlet	6	.167	6	.167	6	.167	5	.200	6	.167	1	1.00	5	.200	5	.200	2.268
41	Arch. Site, Lyell Bay	6	.167	6	.167	6	.167	5	.200	6	.167	1	1.00	5	.200	5	.200	2.268
42	Tidal Flat/Marsh, Island Bay	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
43	Tidal Flat/Marsh, George Bay	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
44	Tidal Flat/Marsh, Slim Inlet	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
45	Tidal Flat/Marsh, Flamingo Inlet	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
46	Tidal Flat/Marsh, Louscoone Inlet	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445

SUMMARY OF MARINE RESOURCE VALUE QUANTIFICATION SCALES

Number		Uniqueness	$\frac{1}{X}$	Rarity	$\frac{1}{X}$	Fragility	$\frac{1}{X}$	Represent.	$\frac{1}{X}$	Scient. Import.	$\frac{1}{X}$	Ecol. Import.	$\frac{1}{X}$	Visibility	$\frac{1}{X}$	Aesthetic Value	$\frac{1}{X}$	$\frac{1}{X}$ Total
47	Tidal Flat/Marsh, Carpenter Bay	4	250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
48	Tidal Flat/Marsh, Rose Inlet	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
49	Tidal Flat/Marsh, Barry Inlet	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
50	Tidal Flat/Marsh, N of Gogit Point	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
51	Tidal Flat/Marsh, Sedgewick Bay	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
52	Tidal Flat/Marsh, Anna Inlet	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
53	Tidal Flat/Marsh, McEchran Cove	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
54	Tidal Flat/Marsh, Lyell Bay	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
55	Tidal Flat/Marsh, Kostan Inlet	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
56	Tidal Flat/Marsh, De la Beche Inlet	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
57	Tidal Flat/Marsh, Haswell Bay	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
58	Tidal Flat/Marsh, Hutton Inlet	4	.250	4	250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
59	Tidal Flat/Marsh, Marshall Inlet	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
60	Tidal Flat/Marsh, Matheson Inlet	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
61	Tidal Flat/Marsh, Echo Harbour	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
62	Tidal Flat/Marsh, Beresford Inlet	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
63	Tidal Flat/Marsh, Windy Bay	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
64	Tidal Flat/Marsh, Powrivco Bay	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
65	Tidal Flat/Marsh, Beljay Bay	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
66	Tidal Flat/Marsh, Takelly Cove	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
67	Tidal Flat/Marsh, Goski Bay	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
68	Tidal Flat/Marsh, Yaklanas Bay	4	.250	4	250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
69	Tidal Flat/Marsh, Luxana Bay	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445

SUMMARY OF MARINE RESOURCE VALUE QUANTIFICATION SCALES

Number		Uniqueness	$\frac{1}{X}$	Rarity	$\frac{1}{X}$	Fragility	$\frac{1}{X}$	Represent.	$\frac{1}{X}$	Scient. Import.	$\frac{1}{X}$	Ecol. Import.	$\frac{1}{X}$	Visibility	$\frac{1}{X}$	Aesthetic Value	$\frac{1}{X}$	$\frac{1}{X}$ Total
70	Tidal Flat/Marsh, Heater Harbour	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
71	Tidal Flat/Marsh, Huston Inlet	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
72	Tidal Flat/Marsh, Harriet Harbour	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
73	Tidal Flat/Marsh, Ikeda Cove	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
74	Tidal Flat/Marsh, Bag Harbour	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
75	Tidal Flat/Marsh, Skaat Harbour	4	.250	4	.250	7	.143	6	.167	7	.143	8	.125	5	.200	6	.167	1.445
76	Seabird Colonies, Lyman Point	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
77	Seabird Colonies, Arichika Island	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
78	Seabird Colonies, Scudder Point	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
79	Seabird Colonies, Bolkus Island	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
80	Seabird Colonies, Dodge Point, Lyell Island	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
81	Seabird Colonies, Kunga & Titul Islands	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
82	Seabird Colonies, Adam Rocks	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
83	Seabird Colonies, Gowgaian & Goski Bays	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	16 7	7	.143	1.345
84	Seabird Colonies, Copper I. & Adj. Islets	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
85	Seabird Colonies, Howay I. & Adj. Islets	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
86	Seabird Colonies, Bush Rock & Adj. Islets	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
87	Seabird Colonies, Swan Island	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
88	Seabird Colonies, Islets W of Dolomite Point	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
89	Seabird Colonies, Wanderer I. & Adj. Islets	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
90	Seabird Colonies, Islet S of Huxley Island	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
91	Seabird Colonies, Nakons Inlet	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
92	Seabird Colonies, Alder Island	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345

SUMMARY OF MARINE RESOURCE VALUE QUANTIFICATION SCALES

Number		Uniqueness	$\frac{1}{X}$	Rarity	$\frac{1}{X}$	Fragility	$\frac{1}{X}$	Represent.	$\frac{1}{X}$	Scient. Import.	$\frac{1}{X}$	Ecol. Import.	$\frac{1}{X}$	Visibility	$\frac{1}{X}$	Aesthetic Value	$\frac{1}{X}$	$\frac{1}{X}$ Total
93	Seabird Colonies, E Shore, Huxley Island	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
94	Seabird Colonies, Marco Island & Adj. Is.	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
95	Seabird Colonies, Hoskins Islets	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
96	Seabird Colonies, Bischof Islands	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
97	Seabird Colonies, Unnamed I., Shuttle Pass.	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
98	Seabird Colonies, Gil Islet	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
99	Seabird Colonies, Rainy Islands	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
100	Seabird Colonies, Goodwin Point	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
101	Seabird Colonies, Nest Islets	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
102	Seabird Colonies, Inner Low Rock	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
103	Seabird Colonies, Gull Islet	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
104	Seabird Colonies, Langtry Island	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
105	Seabird Colonies, Islets, Carpenter Bay	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
106	Seabird Colonies, High Island	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
107	Seabird Colonies, Haydon Rock	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
108	Seabird Colonies, Islets NW of Moore Head	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
109	Seabird Colonies, N Shore, Annis Pt. Pen.	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
110	Seabird Colonies, Isl. in Bay W of Lyman Pt.	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
111	Seabird Colonies, Yadus Pt., Ramsay Island	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
112	Seabird Colonies, Islet N of Andrew Point	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
113	Seabird Colonies, Islet SW of Hotsprings I.	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
114	Seabird Colonies, Hotsprings Island	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
115	Seabird Colonies, House Island	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345

SUMMARY OF MARINE RESOURCE VALUE QUANTIFICATION SCALES

Number		Uniqueness	$\frac{1}{X}$	Rarity	$\frac{1}{X}$	Fragility	$\frac{1}{X}$	Represent.	$\frac{1}{X}$	Scient. Import.	$\frac{1}{X}$	Ecol. Import.	$\frac{1}{X}$	Visibility	$\frac{1}{X}$	Aesthetic Value	$\frac{1}{X}$	$\frac{1}{X}$ Total
116	Seabird Colonies, Murchison Island	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
117	Seabird Colonies, Isls, Tar & Agglomerate I.	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
118	Seabird Colonies, Agglomerate Island	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
119	Seabird Colonies, Tar Islands	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
120	Seabird Colonies, Tuft Islats	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
121	Seabird Colonies, Flatrock Island	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
122	Seabird Colonies, Tuga Point	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
123	Seabird Colonies, Head. N McLean Fraser Pt.	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
124	Seabird Colonies, Pt.W of L. Victoria L. Est.	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
125	Seabird Colonies, Island S of Puffin Cove	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
126	Seabird Colonies, Island W of Puffin Cove	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345
127	Seabird Colonies, S point of Mike Inlet	5	.200	5	.200	8	.125	5	.200	6	.167	7	.143	6	.167	7	.143	1.345

TOTAL "PARK VALUE" SCALE (MARINE)

PRIORITY NO.	FEATURE, SITE, AREA, ETC.	TOTAL PARK VALUE RATIO
1	M. Mammals/Seabird Colonies, St. James I.	1.131
2	Marine Life, Dolomite Narrows	1.204
3	Sea Lion Raft., NW Scudder Pt., Burnaby I.	1.273
4	Marine Life, Faraday Island	1.319
5	Seabird Colonies, Lyman Pt., Kunghit I.	1.345
6	Seabird Colonies, Arichika Island	1.345
7	Seabird Colonies, Scudder Pt., Burnaby I.	1.345
8	Seabird Colonies, Bolkus I.	1.345
9	Seabird Colonies, Dodge Pt., Lyell Island	1.345
10	Seabird Colonies, Kunga & Tital Islands	1.345
11	Seabird Colonies, Adam R., Louscoone In.	1.345
12	Seabird Colonies, Gowgaia & Goski Bays	1.345
13	Seabird Colonies, Copper I. & Adj. Islets	1.345
14	Seabird Colonies, Howay Island	1.345
15	Seabird Colonies, Bush R. & Adj. Islets	1.345
16	Seabird Colonies, Swan Island	1.345
17	Seabird Colonies, Islets W of Dolomite Pt.	1.345
18	Seabird Colonies, Wanderer I. & Adj. Islets	1.345
19	Seabird Colonies, Islet S of Huxley Island	1.345
20	Seabird Colonies, Nakons Inlet	1.345
21	Seabird Colonies, Alder Island	1.345
22	Seabird Colonies, E Shore, Huxley Island	1.345
23	Seabird Colonies, Marco I. & Adj. Islets	1.345
24	Seabird Colonies, Hoskins Islets	1.345
25	Seabird Colonies, Bischof Island	1.345
26	Seabird Colonies, Unnamed I., Shuttle Pa.	1.345
27	Seabird Colonies, Gil Islet	1.345
28	Seabird Colonies, Rainy Island	1.345
29	Seabird Colonies, Goodwin Point	1.345
30	Seabird Colonies, Nest Islets	1.345
31	Seabird Colonies, Inner Low Rock	1.345
32	Seabird Colonies, Gull Inlet	1.345
33	Seabird Colonies, Langtry Island	1.345
34	Seabird Colonies, Islets in Carpenter Bay	1.345
35	Seabird Colonies, High Island	1.345
36	Seabird Colonies, Haydon Rock	1.345
37	Seabird Colonies, NW of Moore Head	1.345
38	Seabird Colonies, N Shore, Annis Pt. Pen.	1.345
39	Seabird Colonies, Islet W of Lyman Pt.	1.345
40	Seabird Colonies, Yadus Pt., Ramsay I.	1.345
41	Seabird Colonies, Islet N of Andrew Pt.	1.345
42	Seabird Colonies, I. SW of Hotsprings I.	1.345
43	Seabird Colonies, Hotsprings Island	1.345
44	Seabird Colonies, House Island	1.345
45	Seabird Colonies, Murchison Island	1.345
46	Seabird Colonies, I. bt. Tar & Agglomerate	1.345
47	Seabird Colonies, Agglomerate Island	1.345
48	Seabird Colonies, Tar Island	1.345

TOTAL "PARK VALUE" SCALE (MARINE)

PRIORITY NO.	FEATURE, SITE, AREA, ETC.	TOTAL PARK VALUE RATIO
49	Seabird Colonies, Rainy Island	1.345
50	Seabird Colonies, Goodwin Point	1.345
51	Seabird Colonies, Tuga Point	1.273
52	Seabird Colonies, N of McLean Fraser Pt.	1345
53	Seabird Colonies, W of L. Victoria L. Est.	1.345
54	Seabird Colonies, Island S of Puffin Cove	1.345
55	Seabird Colonies, Island off Puffin Cove	1.345
56	Seabird Colonies, S Point of Mike Inlet	1.345
57	M. Mammal/Seabird Col., Rankine I.	1.354
58	M. Mammal/Seabird Col., Rankine Island	1.354
59	M. Mammal/Seabird Col., Kerouard I.	1.354
60	M. Mammal/Seabird Col., Anthony Island	1.354
61	Seabird Staging Area, SE of Anthony I.	1.386
62	M. Mammal/Seabird Col., Benjamin Pt.	1.387
63	M. Mammal/Seabird Col., Garcia Rocks	1.387
64	M. Mammal/Seabird Col., Gordon Island	1.387
65	M. Mammal/Seabird Col.,, Tatsung Rock	1.387
66	Seabird Staging Area, St James & Kerouard	1.404
67	Seabird Staging Area, NE of Copper Is.	1.437
68	Tidal Flat/Marsh, Island Bay	1.445
69	Tidal Flat/Marsh, George Bay	1.445
70	Tidal Flat/Marsh, Slim Inlet	1.445
71	Tidal Flat/Marsh, Flamingo Inlet	1.445
72	Tidal Flat/Marsh, Louscoone Inlet	1.445
73	Tidal Flat/Marsh, Carpenter Bay	1.445
74	Tidal Flat/Marsh, Rose Inlet	1.445
75	Tidal Flat/Marsh, Barry Inlet	1.445
76	Tidal Flat/Marsh, Bay N of Gogit Pt.	1.445
77	Tidal Flat/Marsh, Sedgewick Bay	1.445
78	Tidal Flat/Marsh, Anna Inlet	1.445
79	Tidal Flat/Marsh, Mc Echran Cove	1.445
80	Tidal Flat/Marsh, Lyell Bay	1.445
81	Tidal Flat/Marsh, Kostan Inlet	1.445
82	Tidal Flat/Marsh, De La Beche Inlet	1.445
83	Tidal Flat/Marsh, Haswell Bay	1.445
84	Tidal Flat/Marsh, Hutton Inlet	1.445
85	Tidal Flat/Marsh, Marshall Inlet	1.445
86	Tidal Flat/Marsh, Matheson Inlet	1.445
87	Tidal Flat/Marsh, Echo Harbour	1.445
88	Tidal Flat/Marsh, Beresford Inlet	1.445
89	Tidal Flat/Marsh, Windy Bay	1.445
90	Tidal Flat/Marsh, Powrivco Bay	1.445
91	Tidal Flat/Marsh, Beljay Bay	1.445
92	Tidal Flat/Marsh, Takelly Cove	1.445
93	Tidal Flat/Marsh, Goski Bay	1.445
94	Tidal Flat/Marsh, Yaklanas Bay	1.445
95	Tidal Flat/Marsh, Luxana Bay	1.445
96	Tidal Flat/Marsh, Heater Harbour	1.445

TOTAL "PARK VALUE" SCALE (MARINE)

PRIORITY NO.	FEATURE, SITE, AREA, ETC.	TOTAL PARK VALUE RATIO
97	Tidal Flat/Marsh, Huston Inlet	1.445
98	Tidal Flat/Marsh, Harriet Harbour	1.445
100	Tidal Flat/Marsh, Bag Harbour	1.445
101	Tidal Flat/Marsh, Skaat Harbour	1.445
102	M. Mammal/Seabird Col., Gowdas Rocks	1.461
103	Seabird Staging Area, E of Lyman Pt.	1.502
104	Seabird Staging Area, S of Bolkus Island	1.502
105	Seabird Staging Area, W & S of Ramsay I.	1.520
106	Seabird Staging Area, E of Dodge Pt.	1.520
107	Seabird Staging Area, E of Rankin Island	1.520
108	Seabird Staging Area, N of Alder Island	1.544
109	Arch. Site, N of Etches Pt., Louscoone Inlet	2.268
110	Archeological Site, Heater Harbour	2.268
111	Archeological Site, Ross Island	2.268
112	Archeological Site, Huston Inlet	2.268
113	Archeological Site, Slim Inlet	2.268
114	Archeological Site, Bag Harbour	2.268
115	Archeological Site, Dolomite Pt., Island B.	2.268
116	Archeological Site, Matheson Inlet	2.268
117	Archeological Site, Hutton Inlet	2.268
118	Archeological Site, Lyell Bay	2.268
119	Wreck, Sea Gull (1889), Cape St. James	2.900
120	Wreck, Lark (1786), Porter Head	2.900
121	Wreck, San Thomas (1958), Porter Head	3.067
122	Wreck, Scrub (1950), Copper Islands	3.067
123	Wreck, Superior (1948), Tasu Sound	3.067
124	Wreck, Thelma G (1930), Cape St. James	3.067
125	Wreck, Galiano (1918), Cape St. James	3.067
126	Queen Charlotte Fault	3.260
127	Louscoone Inlet Fault	4.358

a) RESOURCE ANALYSIS

But for drowned archaeological sites and shipwrecks, the marine environment of the park reserve is comprised solely of natural resources. The marine environment imposes its own special limitations on the discovery and evaluation of both man-made and natural resources in that the marine environment is relatively hostile and impenetrable to humans except under the highly specialized, limited, time-consuming and expensive conditions afforded by SCUBA gear, submersible or remote underwater diving apparatus.

The sensitive marine resources of the proposed marine park reserve are largely those of the intertidal zone. That interface enjoys both enhanced biological activity and high hydrological energies. The biota of the area are, many of them, dependent upon the influences of both the marine and terrestrial environments for their success.

- Management Concerns

The same special conditions imposed by the marine environment on the evaluation and discovery of both man-made and natural marine resources likewise restrict the ability to manage and protect those resources. The ability of the resource managers, and in particular the Park Warden Service, to operate in the marine environment must be at least equal to those who would visit that environment, be it for legitimate recreational purposes or with the intent of engaging in illicit activities.

It is not only sensitive marine resources which are concentrated along the shoreline, particularly in the intertidal zone, but human activity is largely coastwise as well. Few visitors will see much of the interior of South Moresby and adjacent islands. Likewise, few people will venture into the submarine environment. Activity will be on the water surface for the most part, with some shoreline contact. It is incumbent upon managers to see that users of the proposed marine reserve understand the sensitivity of the marine resources, particularly those concentrated along the shore.

- Status of Knowledge

Knowledge of the sensitive marine resources of the proposed park reserve is limited to a variety of disjunct studies and surveys, each with varying purposes. With respect in particular to the highly susceptible shoreline environment, the current knowledge base requires improvement.

b) SELECT REFERENCE SOURCES

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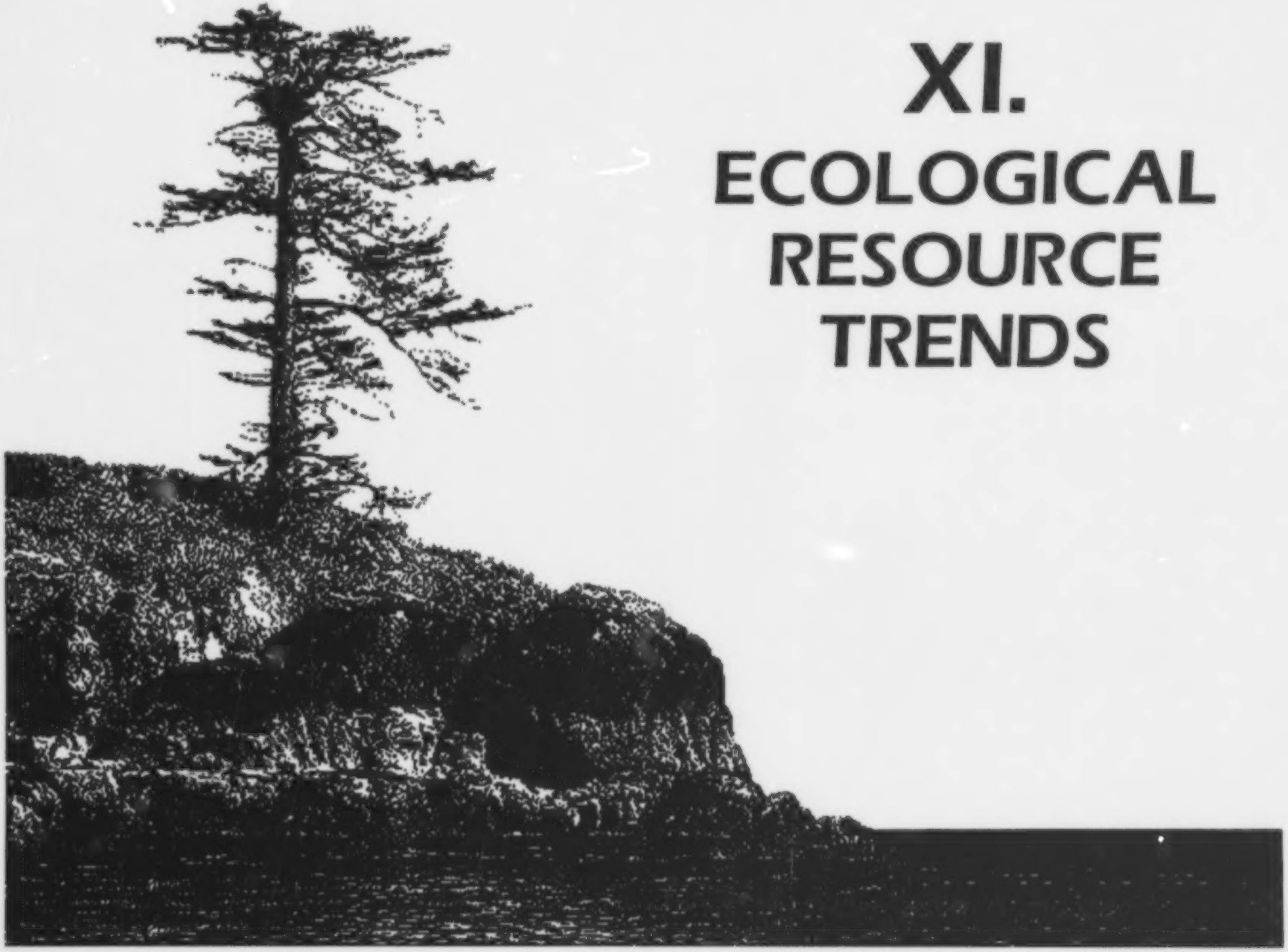
XI.

ECOLOGICAL RESOURCE TRENDS



ECOLOGICAL RESOURCE TRENDS

- General Overview

Broadly speaking, the ecological trends the natural resources of the Queen Charlotte Islands have been responding to in their evolutionary journey through the past millennia must be seen as the direct result of their isolation as an island archipelago well removed from the continental mainland coast of northwestern British Columbia. Prior to that, and for countless eons, the evolution of the Islands progressed with only the scantest of records left to be read in the rocks now exposed to examination. From that record we know about the long journey of several small oceanic land masses driven northward by tectonic forces from south of what is now the equator. Sometime during that slow journey, the land masses accreted to form the prototype of the Queen Charlotte Islands and, through vast plate tectonic movements, became translocated to their present location. The record also shows that plant and animal life underwent many cycles of evolution on the land and in the seas of the archipelago.

The enquiring methods of modern science are only now beginning to unravel some of the early postglacial records that are believed to have a direct connection to the more recent environmental evolution of the Queen Charlotte Islands, in that they provide us with the first clues of why the landscapes and life on the Islands evolved in the manner that they did and why certain ecological trends developed as they did. Those primarily "nature-driven" processes were interfered with severely, when resource extractive commercial activities were first introduced and superimposed upon the purely natural scheme of things at the end of the past century. Since that time, the removal of vast tracts of timber, the onset of mineral exploration and mining, and the introduction of a number of alien wild and domestic animal species to the Islands have severely altered the environment of the Islands and set into motion an entire set of new ecological trends, the probable effects of which nobody has yet taken the time to study.

Several researchers have over the years drawn attention to the fact that their works included observations of certain aspects of the natural system having been impacted and altered severely by some or all of the previously mentioned impositions. While several of the severest impacts on the natural environment of the Islands are readily visible to even a casual observer, it is suspected that many other environmental impacts are much more subtle, and may not for years give any indication of how much they have affected, or are affecting, the redirection of normal ecological trends. For the present, the literature is not too forthcoming with hard scientific facts about the forces at work changing the natural ecological trends. That is not to say that the literature is devoid of popularized environmental messages and emotional appeals on the subject matter of the deterioration of the environmental quality on the Queen Charlotte Islands. In fact, the opposite is true!

Nevertheless, there is at the moment an insufficient data base on the subject to begin to provide any more than the barest introduction to the intent of this section's role in the description of the natural resources of the South Moresby / Gwaii Haanas National Park Reserve. The assumption is made that it will take years of dedicated and concentrated research before the required level of knowledge and understanding can be reached.

A. TERRESTRIAL RESOURCE TRENDS

1. Regional Park Perspective.

It is clear that, in spite of their isolation from the mainland, the Queen Charlotte Islands have been able to attract people to their shores for many years, irrespective of the people's origin or purpose. The numbers of the migrants and visitors have never been large, and only some of them stayed and made their home on the Islands, but their collective impact on the local culture, economic expansion, and development, has been significant. Even very early on in the European involvement with the Islands, it became apparent that the archipelago and its native people were sufficiently different from the mainland that they attracted the interests and attentions of the top scholars and scientists of the day. Once they had described, and thereby drawn attention to, the wealth of natural resources present, the Islands began to attract a large number of entrepreneurs who initiated decades of economic development and exploitation of the terrestrial resources. In contrast to the settlement and intensive development that took place on Graham Island, the more remote southern portions of Moresby Island, where the national park reserve is now located, largely escaped the periods of intensive exploitation and settlement.

With the exception of a small number of specific concentrations of commercial activity, few sites and locations on land appear to have attracted any serious tourism or recreational visitor activities. The isolation of the Islands from the major concentrations of potential tourists, and the difficulty of access and its costliness, appear to have exerted a considerable retarding effect on the early development of a locally based tourism industry; that is, in relation to the remainder of the country. Tourism, in the modern meaning of the word, did not really take hold on the Islands and its general region until well after the end of the 2nd World War, when Canada as a whole began to undergo tremendous social and economic changes. Since that time, the government of British Columbia has designated the Queen Charlotte Islands to be the island extension of the "North by Northwest Tourist Region", and thereby raised the destination appeal of the Islands to a new level. It is not clear if the provincial advertising efforts, the clamour of the environmental lobby groups on the west coast, or a combination of the two, can be be held responsible for the significant increases in tourism during this decade. Provincial reports claim a 14 percent growth in local tourism during the period from 1985 to 1986, while a 28 percent increase in visitation was anticipated by local tourism operators for the year 1987.

As a result of the Memorandum of Agreement between the Government of Canada and the Government of the Province of British Columbia, signed in 1988, an eight year commitment was made by the federal government to commit a total sum of 50 million dollars for Queen Charlotte Island's Regional Economic Development Initiative. There can be little if any doubt that the trend in tourism development on the Islands has been placed on a firm base by that initiative.

2. Regional Climate.

The South Moresby / Gwaii Haanas National Park Reserve, as part of the Queen Charlotte Islands, is now the primary example of west coast climate within the national park system. This climate finds expression in two similar, yet different, ecoclimatic regions; *i.e..*, the *Maritime South Pacific Cordilleran*, and the *Oceanic South Pacific Cordilleran* (Anon. 1989e). The ecological effectiveness of this climate has found expression in the successional trends of the vegetation and soils now present on the Islands, all of which were discussed in greater detail under the appropriate sections.

The climatic trends experienced over the past few millennia since early postglacial time, which have placed this period of earth's climatic history into an interglacial epoch, are the direct result of the interactions of a number of environmental factors, some of which are in a constant state of flux; *e.g.*, incoming energy from the sun, the tilt of the earth's axis in relation to the sun, the movement of captured solar energy through large-scale airmass circulation, the distribution of oceans and continents, and the influences brought about by the local and regional topography.

The present period of time has been undergoing series of climatic fluctuations of minor amplitude, but statements have already been made in the literature that, as the earth's atmosphere undergoes certain known and broad cyclic changes within its total climate regime, more major fluctuations can be expected, including future glacial periods. Meanwhile, and under normal conditions, climatic trends are not expected to be noticeably different from present ones within the near future. However, some rather abnormal conditions have been created in the past few decades by the excessive release of carbon dioxide and other gases into the atmosphere by worldwide industrial activity, transportation, and chemical processes. Most recent journals on the subject matter discuss and decry the large potential of these activities and processes to disrupt the climatic trends of the next few decades. If the man-made disruptions reach a high enough degree, they might begin to act on the local and regional scales of the earth's climate in largely unpredictable patterns. There are presently no suggestions if or how such patterns might affect the Queen Charlotte Islands in the near future.

3. Water Resources .

In keeping with the high precipitation regime experienced along the outer coast of northwestern British Columbia, the Queen Charlotte Islands are known for their "well-watered" condition and their rich and diverse aquatic habitats. Even though postglacial conditions are believed to have been fully entrenched by about ten millennia ago, the general steepness of most of the terrain of the Islands and the narrowness of their landmass have prevented the evolution of fully matured multi-river drainage systems. Those river systems that have developed are quite short, and with little exception, maintain a high velocity regime as they plunge from the height of land to sealevel in but a few kilometres. Lakes have formed in cirques and depressions of this glacially sculptured land, and serve mainly to temporarily retain runoff waters on their rush to the sea.

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The ecological trends affecting the freshwater resources within the national park reserve on South Moresby Island have been and still are strongly controlled both by the physical configuration of the landmass and the high rate of precipitation. There is at the moment no evidence to suggest that the climatic perturbations known to have occurred during the past few millennia were fundamentally different from those being experienced today, even if they were occasionally cooler or wetter. Today's aquatic environments show all the signs of being the result of long periods of relative climatic stability, and unless disproven, it is believed that the broad natural trends affecting the water resources on the Islands will continue as they are into the near future.

4. Geological Resources .

In accordance with modern concepts of the earth's plate tectonic processes, the geological history of the Queen Charlotte Islands has been evolving along trends established hundreds of millions of years ago at plate margins, sutures, and rift zones, associated with the relentless seafloor-spreading movements of the Pacific Plate. Their present petrology, topography, and location, just off the coastline of mainland British Columbia, is but a short interlude in the continuing unfolding of the geological history of the margin between the North American Plate and the various sub-plates of the Pacific Plate.

Recent seismic events in the vicinity of the city of San Francisco in the State of California, serve to underscore the fact that the plates are in inexorable motion in relation to one another. Because the Queen Charlotte Fault, just off the west coast of the Islands, is but one of a continuous series of complex faults extending northward from the seismically active San Andreas Fault, earthquake activity can be expected to continue into the future. The actual rate of movement along the Queen Charlotte Fault has been estimated to amount to about 55 millimetres per year, and 359 earthquakes have been recorded by the Geological Survey of Canada in the South Moresby area since data recording began in 1899. Secondary faults branching off the Queen Charlotte Fault literally criss-cross the Islands; *i.e.*, the Rennell Sound Fault, the Louscoone Inlet Fault, the Inlet Fault, and the Sandspit Fault, have all been seismically active in historical times. The most recent seismic activity of notable strength occurred along the Rennell Sound Fault, when the occurrence of an earthquake epicentre was recorded in the Werner Bay - Hutton Inlet area.

The foregoing discussion clearly indicates that the area of the national park reserve on South Moresby Island lies within a zone of the highest seismic risk and is part of the most earthquake-prone area anywhere in Canada. Strong ground movements not only have been experienced in historical times, but are very likely to be recurring throughout the foreseeable future.

5. Soil Resources .

The trends of soil development are almost entirely under the control of the major environmental factors such as physiography, geology, climate, vegetation, and other biological life forms (Jenny, 1980). It is therefore believed to be valid to state that the evaluation of the ecological trends inherent in the soils of the South Moresby / Gwaii Haanas National Park Reserve, can be reasonably well predicted through the monitoring of the environmental factors that affect the soils. It must be kept in mind, however, that soil development processes operate in an extremely slow manner, and are usually found to be somewhat out of synchrony with the normal perturbations that affect the environmental factors which initiated the soil development in the first place.

Notwithstanding the foregoing statement, certain natural processes and man-induced activities have the potential to impact upon soils and soil developmental processes quite catastrophically. In the case of this national park reserve, slope failures due to water-logging of the soils and seismic activity, and the removal of the vegetation cover and the associated severity of soil disturbance, are but two obvious examples of complex local interactions. In spite of the fact that only the broadest form of knowledge, and hence understanding, of the soils of the national park reserve are available at this time, the following and equally broad soil trend predictions can be made without fear of committing serious errors in judgement:

a. Undisturbed soils of the podzolic, brunisolic, gleysolic, and organic orders, are expected to continue to evolve along their present courses as long as the environmental factors acting upon them remain essentially unchanged.

b. The potential exists for some of the stabilized soil deposits of the regosolic order to evolve over time to a higher and more mature soil order.

c. Only long-term soil monitoring will establish the effects on the various soil orders that underwent severe disturbances caused by natural processes, logging, and other extractive and developmental activities.

6. Vegetation Resources .

Calder and Taylor (1968) were the first researchers to seriously study the flora of the Queen Charlotte Islands and discuss its history. Even though they recognized the weaknesses in some of their conjectures, they left us with a much better idea of how the present vegetation communities might have evolved, and allows us to undertake some informed guesswork about what the future might hold for them. Following is the spatial distribution of the plant species they collected on the Islands:

a. 144 wide-ranging species occur throughout or almost throughout the Queen Charlotte Islands.

b. 122 species are essentially restricted to the Queen Charlotte Ranges and mountainous areas of the Skidegate Plateau.

c. 72 species are essentially restricted to the saline or brackish conditions of the seashores.

d. 115 species are essentially restricted to the Lowlands of eastern Graham and eastern Moresby Islands.

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Calder and Taylor (1968) also provided us with an overview of the relationship of the indigenous flora of the Islands with other regions of the world. They summarized the distributional affinities of 472 adequately known taxa as follows:

Distribution:	Taxa:	% of Flora:
N. American only	242	(51.3 %)
North American and Asian	89	(18.9 %)
N. & S. American	4	(0.8 %)
N. American, South American, European	1	(0.2 %)
Circumpolar - Circumboreal	136	(28.8 %)

They further described the development of the glacial history and distributional patterns of the present flora by categorization of the affinities of the indigenous North American taxa on the Queen Charlotte Islands:

1. *Pacific Coastal Elements*
= 94 taxa, or 38.8 % of the flora; of which 11 taxa (4.5%) were Queen Charlotte Islands endemics; 6 taxa (2.5%) were distributed across the Islands, the B.C. coast and adjacent Alaska; 37 taxa (15.3%) were distributed from the Alaska panhandle to Washington, Oregon or California; 40 taxa (16.5%) were distributed from the Aleutian Islands or the Gulf of Alaska to Washington, Oregon or California.

2. *Wide-ranging Cordilleran Elements*
= 98 taxa, or 40.5 % of the flora.

3. *Wide-ranging North American Elements*
= 50 taxa, or 20.7 % of the flora.

Calder and Taylor (1968) employed these figures to argue that the number of disjunct species now present, and the degree of speciation evident on the Queen Charlotte Islands, are directly related to the still hypothetical presence of one or more refugia on headlands and along fjords on the west coast of the Islands during maxima of the Pleistocene glacial advances. More importantly, they arrived at the conclusion that the Queen Charlotte Islands represent a centre of postglacial plant radiation. Making the assumption that their conclusions were correct, certain trend predictions could be postulated, were it not for the fact that one quarter of the present flora are introduced taxa, the massive disruption of the vegetation cover caused by agricultural practices, logging, infrastructural developments, and the introduction of alien wildlife species and livestock. Much more needs to be known about this subject matter before some of the major implications can be understood.

7. Wildlife Resources.

The case for speculating about the ecological trends of terrestrial wildlife populations on the Queen Charlotte Islands is even weaker than the one just described for the vegetation resources. Foster (1963) was the first researcher to seriously study and discuss the evolution of native land mammals in relation to the problem of their insularity. He postulated, for instance, that the uniqueness of the local mammal fauna could be the product of insular evolution, or that it could be due to their being geographical relicts. Though having only circumstantial evidence available, he clearly favoured the insular evolution theory because of the uniformity of physical characteristics displayed by insular birds and mammals, as compared with the characteristics of relatives living on the mainland.

With the limited background information available about wildlife species in general, and on the subject matter as a whole, the discussion of the ecological trends likely to affect the populations of individual species is at this time not perceived to be a valid activity. This is particularly so in the light of the many introductions of bird and animal species to the Islands during the past century; *e.g.*, starlings, black rats, raccoons, and black-tailed deer, all of which are now known to have been highly disruptive to the insular ecology. Likewise, it is not known how many wildlife species have been extirpated through natural processes or through human activities and development during the same time period.

Even the invocation of total protection for all wildlife species under the auspices of the national park reserve is highly unlikely to reverse the trends initiated by the past introductions and disruptions visited upon the Islands. As well, the levels of general knowledge about terrestrial wildlife, are so limited that the need for research is extensive.

8. Archaeological & Historical Resources.

Even though the broad importance and value of the local cultural heritage resources to the nation and the world were well established prior to the establishment of the South Moresby / Gwaii Haanas National Park Reserve, our present understanding of the early archaeology of the Haida people, and of the collective history of the Queen Charlotte Islands since post-contact times, is far from complete.

All currently available information must first be formally synthesized and evaluated by experts in the fields of human history before the requirements for future research can be fully assessed and appreciated. These two approaches are mutually supportive, and would lead, in due course, to the establishment of a rational data base upon which all future cultural heritage activities could be based. The potential local and national benefits likely to accrue are too obvious to require explanation. They would also serve to meet our international obligations.

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More importantly, in the context of this section, a formal approach to the study, understanding, and presentation of the heritage resources of the Islands, would:

a. establish the trend for long-term development of a better knowledge than currently exists;

b. significantly enhance the level of the appreciation for cultural heritage resources; and . . .

c. provide the necessary information for park interpreters and visitor services personnel to communicate all aspects of the local human history to future park visitors.

9. Past & Present Land Use .

The information base about past land uses remains incomplete, but enough is now known to make the following prediction. Land uses within the South Moresby / Gwaii Haanas National Park Reserve are likely to increase significantly, but the types of highly concentrated, resource extractive land uses experienced from the past to the present, will be largely replaced with widely dispersed activities aimed at resource protection, nature appreciation, and recreation.

Future land use trends will be aimed at establishing an ecologically sound and socially acceptable park infrastructure encompassing transportation and communication corridors, visitor activity nodes, resource management activities, public safety programs, and law enforcement. While it is not possible at this time to predict in which manner and with what urgency these developments will take place, the important point to be made is that they will take place within the commitments of the published National Park Policy. These policy commitments clearly provide:

a. for the approved management planning processes to precede any actual land uses and infrastructural developments; and . . .

b. to provide for broad public input into the planning of the park's future.

10. Sensitive Resources .

The number of sensitive resources thus far identified within South Moresby / Gwaii Haanas National Park Reserve, represent no more than the most obvious of features, sites, or areas, identified from the literature consulted. With the exception of the Haida World Heritage Site at Ninstints, no archaeologically sensitive resources were even considered for inclusion at this time. This arbitrary decision was based on the belief that our present base of knowledge about these cultural resources within the national park reserve is too insufficient to base such evaluations upon. That status will be corrected as soon as our levels of knowledge and understanding improve.

Meanwhile, the number of sensitive resources is expected to increase significantly, as our familiarity with this national park reserve increases through occasional visits and more indirect contacts with the sensitive resources. The trend to be able to identify and list additional sensitive resources is, therefore, also expected to increase quite naturally in the next few years.

a) RESOURCE ANALYSIS

Canadian National Parks Service personnel are currently not in the position to make knowledgeable and therefore intelligent "ecological trend" predictions about most of the natural resources within the South Moresby / Gwaii Haanas National Park Reserve. This situation is based on both the very limited information available about many of the natural resources there, as well as on our lack of familiarity with the actual landmass of the reserve.

Furthermore, the resource data consulted fails, in almost all instances, to address the ecological trend aspects of the resources described. This situation is, unfortunately, not expected to improve much in the near future, unless the Canadian Parks Service is prepared to invest funds in the resolution of this dilemma.

- Management Concerns

Two primary management concerns are recognized. -

The first concern addresses the very real possibility that park managers may be forced to undertake physical and infrastructural developments prior to having had the opportunity to review a better and more current resource data base than is presently available. Such a situation would have the potential of obscuring any natural ecological trends that may otherwise be recognizable, or of further damaging those ecological trends that have already been altered and are now on an aberrant ecological course.

The second concern addresses the requirement for substantial amounts of funding to overcome the serious lack of resource management-related ecological trend information. The most important step required to overcome the problem of a limited data base is to invest funding in the initiation of an ecological land classification project that would provide the required information at a scale conducive to that goal.

- Status of Knowledge

Based on the scientific and technical literature reviewed to date, our present status of knowledge is too insufficient in depth and in quality to make any further comments about the ecological trends acting upon the South Moresby / Gwaii Haanas National Park Reserve.

b) SELECT REFERENCE SOURCES

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B. MARINE RESOURCE TRENDS

1. Regional Marine Perspective.

The Queen Charlotte Islands area has been placed in a socio-economic regional perspective already (see Terrestrial Resource Trends: 1. Regional Park Perspective). The attraction of the Queen Charlotte Islands to both migrants and visitors has largely been due to the bounty bestowed upon the inhabitants by the sea. The as yet unrealized potential of the marine environment to attract tourism may be the single most important precursor of a trend which could change the nature of the regional perspective for the Queen Charlotte Islands and their surrounding waters.

Localized changes wrought by mankind on the marine environment have been mitigated by the fact that the marine environment is not a bounded system like the terrestrial environment, but one which is a part of a very much larger regional and, indeed, worldwide marine environment. Not only are the waters, the substrate and their inhabiting biota within the proposed national park reserve subject to many influences outside of the very artificial boundaries of the reserve, but they in turn have an effect on the much broader environment of the world oceans. The highly transient nature of much of the marine biota further broadens the perspective in which the marine environment of the proposed South Moresby National Marine Park Reserve must be considered.

2. Regional Marine Climate.

All that has been said for the regional terrestrial climate in terms of ecological trends (see Terrestrial Resource Trends: 2. Regional Climate) applies to the marine climate. The climate of the region is, in fact, largely a result of the interactions of atmosphere and ocean. The hydrologic cycle links the two; wind can affect ocean currents, upwelling and general circulation; and oceanic currents supply energy which helps to propel circulation in the atmosphere.

If the meteorological record is relatively new and both temporally and spatially sporadic for the terrestrial environment, it is even more so for the marine environment. Consequently, marine climatic trends are difficult to identify at this time. Modern climate has been relatively stable, and the action of the ocean as a heat sink has tended to ameliorate the kinds of fluctuations which are evident for a terrestrial climatic situation.

3. Oceanography.

The history of oceanographic processes of the Queen Charlotte Islands region has relied upon much the same sort of opportunistic records that form the marine climate history. Both hydrologic and oceanographic information were often gathered by the same vessels. Waves, tides and circulatory patterns tend to undergo seasonal fluctuations akin to weather patterns, but with a knowledge base dating only to 1934 (and in a very patchy record), oceanographic trends in the region are no more predictable than marine climatic trends.

One important oceanographic phenomenon which owes its origin not to climatic events but to geological events is the Tsunami. To the extent that seismic activity in the area can be predicted not as a trend but as a likelihood, so there is the likelihood of Tsunami activity in the region.

4. Marine Geological Resources.

Tectonically speaking, the marine and terrestrial geology of the Queen Charlotte Islands are inseparable. The geomorphological youth of the northeastern part of the Pacific Ocean basin is demonstrated by the very fact that the Pacific Plate continues to subtend the North America Plate at the rate of movement of 55 millimetres per year along the Queen Charlotte Fault. That movement and movement by secondary faults, notably the Rennell Sound Fault and the Louscoone Inlet Fault, make the Queen Charlotte Islands area the most geologically active area in Canada. Further seismic activity is inevitable in the region. Such activity has the ability to generate both submarine slides and Tsumnamis of destructive proportions.

5. Marine Soil Resources.

To describe marine sediments as marine soils is an artificial distinction. Nonetheless, marine sediments are rapidly dynamic, unlike other geological resources. By virtue of the the narrow Continental shelf and steep Continental slope off the west coast of the Queen Charlotte Islands, sediments derived from the continual erosion of the adjacent land are allowed to move down-slope. Cuts such as the Moresby Channel and the Scott Channel in the broader parts of the Continental shelf also act as debris channels for downward sediment transport. Shoreline accumulations of sediments are prevented on the west coast of the Queen Charlotte Islands by steep shorelines and high wave energy levels, but such is not the case on the more sheltered eastern shore. Catastrophic sediment transport (submarine slides) are a consequence of the frequent seismic activity in the region.

6. Marine Vegetation Resources.

In the days when sea otter were plentiful in the Queen Charlotte Islands, beds of giant kelp abounded. With the elimination of the sea otter, a growing sea urchin population destroyed many of the large kelp beds. There has been no attempt within the Queen Charlotte Islands to reverse the trend by restoring sea otter habitat. The harvest of kelp and the artificially maintained row-on-kelp fishery do not help.

Beach communities in the Pacific Northwest have evolved for the past century with the influence of a pervasive human factor: the presence of drift logs which are largely those lost from logging rafts or booms. Forest resource technology has now evolved to the point that easily lost log rafts are scarce and even the more secure bundle booms are giving way to log barges as a means of transport. The extra security afforded by the barging of logs means that fewer are lost each year to become part of the drift log barrier which has been so common to our shores. Beach communities must necessarily change as a result, though the changes will likely be slow to happen.

Sparse to begin with due to the geomorphological youth of the area, healthy marine wetlands are growing ever more scarce along the British Columbia coast as a result of dyking, log storage, landfill, dredging and pollution. In consequence, the remaining healthy wetlands will face increasing pressure to support the numerous migratory waterfowl populations which rely upon them for food, shelter, and breeding grounds.

7. Marine Wildlife Resources.

The marine wildlife resource has not been subject to the same debate over insularity nor the same problems of artificial species introduction as has the terrestrial wildlife resource. Nonetheless, the activities of humankind have not been without ecological consequence for marine faunal evolution in the Queen Charlotte Islands. That is particularly true for the once common sea otter which was eliminated by hunting. And certain of the cetacean populations were drastically reduced in number by hunting to the point that they have yet to rebound. Population trends for migratory species are difficult to forecast. Seabird and pinniped populations have exhibited a decline. Declines in Steller sea lions have been linked to diminishing fish stocks (Stirrup 1990). Fish populations fluctuate dramatically every year.

8. Marine Archaeological and Historic Resources.

Few marine archaeological and historic resources have been identified in the Queen Charlotte Islands. It can be expected that many more such sites will be identified in a systematic marine archaeological investigation of the area within the proposed national marine park reserve. In addition, terrestrial investigations may be expected to uncover more sites associated with historically higher water levels. The early identification of marine archaeological and historical resources is imperative in light of the inexorable trend towards decay and burial under both sedimentary and vegetative debris.

9. Marine Resource Use.

The ban on resource extraction which accompanies the designation of the national park will not extend to many of the resources of the proposed national marine park reserve. While mineral resources can be expected to be protected, the same is not true of the floral and faunal resources. The trend is for both sport and commercial fishery pressures to increase annually. The move towards tourism to compensate for a loss of forestry opportunities can be expected to lead to increasing non-extractive marine resource use.

10. Sensitive Marine Resources.

As is the case with the archaeological and historical resources of the proposed national marine park reserve, so the sensitive marine resources are far from completely identified. The number of sensitive marine resources identified can be expected to increase as the knowledge base grows. That is particularly true in the case of sensitive archaeological resources of which few have been identified.

a) RESOURCE ANALYSIS

- Management Concerns

The boundless nature of the marine environment dictates that management of the proposed national marine park reserve must consider a natural resource management perspective which takes into account both the migratory nature of the majority of the marine biota and the overwhelming influence of the marine environment beyond the artificially-imposed boundaries of the park. The old paradigms of terrestrial resource management do not apply in the marine environment.

Apart from the resource-extractive impacts of the various marine fisheries, the impacts of human activity in the QueenCharlotte Islands are felt largely along the shoreline. Any trends towards increased visitation to the area, for whatever purpose, will necessarily impact upon the sensitive biota of the foreshore.

What marine floral and faunal trends have been apparent are largely due to the resource-extractive activities of man. The question of whether those trends should be consciously reversed or not (as by re-introducing sea otter) is one that deserves consideration.

Sensitive resources, particularly sensitive archaeological resources, are incompletely described. That deficiency deserves early correction, particularly in advance of the likely increase in visitation which will accompany the development of the national park and national marine park reserve.

Given the level of understanding which we now have of the marine resources of the proposed national marine park area, it is incumbent upon management to err always on the side of caution and conservatism when speculating about ecological trends.

- Status of Knowledge

The prediction of ecological trends implies a knowledge of the history of resource ecology which is largely lacking for the marine environment of the proposed national marine park reserve. Steps can be taken to improve our present day knowledge immediately, but the forecast of trends requires a monitoring history from which to discern patterns. Such a record can only be developed over time, which is all the more reason to launch upon an improvement of our status of knowledge at the earliest opportunity.

b) SELECT REFERENCE SOURCES

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RESOURCE EVALUATION

Introduction.

The purpose of Part 3 is to provide a preliminary evaluation of the natural resources of the South Moresby / Gwaii Haanas National Park Reserve, as described in Part 2 of this Resource Description & Analysis, in terms of:

a.) a first approximation of the basic capabilities and limitations of each major resource category to sustain the various mandated programs of the Canadian Parks Service without the loss of environmental quality;

b.) the recognized scientific importance of the natural resources of the park reserve , and the interest the academic community has shown, or is showing, in the same resources; and...

c.) the most conservative resource management options and alternatives that ought to be considered until such a point in time, that the resource information base has been substantially broadened beyond the present levels of knowledge.

The sections of this preliminary evaluation take on a special importance, in that the South Moresby / Gwaii Haanas National Park Reserve was declared to be the first sizable area on a Pacific west coast island in the Canadian national park system, consisting both of large terrestrial and marine components. As such, the following individual evaluations present no more than the first tentative extrapolations by national park staff, about an area of which the natural resource details remain largely an unknown quantity, and the political future of which is only charted in the broadest of terms. In other words, the authors of this document fully expect to have to provide future updates of the present resource evaluations, as the clarification of the political picture and scientific research are able to broaden the general knowledge base in the meantime.

The present level of evaluation will, therefore, serve largely to draw attention to (a) potential resource / land use interactions, rather than actual ones; and (b) the obvious shortcomings within the available information base. In the due course of time, other parts of the Natural Resource Management Process (Anon. 1979d) will undertake to address the relationship between the need for the various future resource management activities likely to occur, and the capability of the natural resources to sustain them.

A. TERRESTRIAL RESOURCE EVALUATION

i. Regional Park Perspective

- Resource Capabilities.

Because of the peculiar spatial configuration of the "North by Northwest" Tourist Region of British Columbia, of which the Queen Charlotte Islands appear to be only an offshore appendage, it is very difficult to ascertain how, or to what degree, the presence of a national park reserve on South Moresby Island might affect tourism in the region as a whole. The available literature certainly does not address such a question.

It is considerably easier to make the presumption that the new national park reserve on the Queen Charlotte Islands will, in due course, exert sufficient impetus on the tourist industry in the area to raise it from its present localized level to one of considerably greater political, economic, social, and international importance within the region as a whole. It is quite probable that the national park reserve may become the primary tourist destination within the "North by Northwest" Tourist Region. This suggestion is based on the fact that the terrestrial landmass of the park reserve was selected for park purposes on the basis of possessing a substantial potential for aesthetic and recreational enjoyment, cultural and natural history activities, and scientific investigation opportunities for all future visitors to the area. In other words, the South Moresby / Gwaii Haanas National Park Reserve is unique within its tourist region, and may be developed into its main attraction.

It is also believed that the potential exists for the services mandated by the National Parks Policy to be withstood by the natural resources with only minor local disruptions of the environment, and then only after the full force of the federal Environmental Assessment & Review Process (Anon. 1984b) has been brought to bear. However, considerably more research must first be conducted to verify that belief.

- Resource Limitations.

The absence of infrastructural highway and facility systems, the relatively limited and costly modes of access currently available, the obvious remoteness of the island, and the rigorous local oceanic climate, will challenge the ingenuity of park planners for years to come if the the full range of environmental and recreational capabilities of this national park reserve are to be made available to all levels of Canadian society and international guests.

In addition, certain political decisions must yet be taken to finally rally the federal, provincial, and native management agencies to the common cause of bringing the Queen Charlotte Island Regional Economic Development Initiative to timely fruition. The lack of movement on this and several other outstanding major issues affecting the planning and development of the park reserve has imposed artificial limitations on the application of almost all initiatives to the park reserve and its extra-park support areas and facilities.

- Scientific Interest and Importance.

The Queen Charlotte Island archipelago, as only a small part of a much larger provincial tourist region, has attracted a considerable amount of academic attention; that is to say, at least during the past decade. However, studies conducted since European scientists first arrived on the shores of the Islands were for the most part directed towards gaining a broad overview of their natural and socio-cultural history, and their economic exploitation. The somewhat remote area of the national park reserve, is now known to have been studied to a lesser extent than have the other areas of the archipelago. Yet it is believed that, because of that situation and the urgent requirement for environmental information, the area encompassed by the national park reserve not only demands increased scientific interest, but has also retained a high degree of importance to attract both socio-cultural and physical scientists.

More specifically, the entire fields of tourism and marketing require immediate and serious study in order to provide the background information required to allow socio-cultural park planners to plot both the course of future facility and activity development programs and their integration with extra-park programs. Similarly, physical and ecological earth science studies are required to provide resource management planners and resource managers with the technical and scientific data about the natural region. These basic research requirements are the requisite to preserving, protecting, and ecologically managing the natural environment of the national park reserve. The importance of carrying out these tasks has been repeatedly demonstrated, and the scientific interest in conducting such research is known to exist in the academic community. Only the manner in which such studies are to be conducted and funded requires negotiation.

- Management Options / Alternatives.

The primary management option for the South Moresby / Gwaii Haanas National Park Reserve was established on July 12th, 1988, when the Government of Canada and the Province of British Columbia jointly signed a "Memorandum of Agreement" to transfer the land and ocean areas to establish the park. It is to be expected that the intent of the agreement is to be met in all of its different expressions.

As part of the agreement, the major initiative likely to have the most immediate effect on the region as a whole, is the Queen Charlotte Islands Regional Economic Development Initiative. This initiative is scheduled to expend up to 50 million dollars within the eight years following the signing of the agreement; that is, principally on: (a) the construction of a small craft harbour in the vicinity of the hamlet of Sandspit, and (b) the construction and operation of visitor reception centres at Sandspit and Queen Charlotte City. In addition, the federal government will undertake the construction of a boat launching and visitor information facility at Gordon Cove, to serve as the "jumping off" point for visitors to the park.

These legally prescribed initiative options are expected to provide the first opportunities to observe and study the regional and park reserve user patterns and trends likely to evolve under the future management strategies. However, while it is recognized that there may be any number of alternatives to reach the goals of the initiatives, none appear to have been selected and declared active to date.

II. Regional Climate

- Resource Capabilities.

The climatic factors that have given rise to the characteristically mild winter and cool summer conditions which differentiate the Queen Charlotte Islands from the mainland climate at the same latitudes (Anon. 1988d) have caused a distinct bio-physical environment to evolve on the archipelago. Frequent cloud cover, a very high precipitation regime, and temperatures moderated by the close proximity of the Pacific Ocean, in combination with the longest growing season in Canada, have provided the environmental conditions for both the growth of a vigorous forest vegetation cover in the first instance, and the quick vegetation recovery following disturbance, in the second instance.

Though said to be an island community depauperate of wildlife species, the native terrestrial birds and animals appear to be well adapted to the peculiar climate. Even those wildlife and domestic species introduced since Europeans first visited the Islands have flourished under the existing climatic conditions, as has the human population. It is believed that this unique West Coast climate and the planned improvements in access to the archipelago, and the South Moresby / Gwaii Haanas National Park Reserve in particular, will serve to attract increased numbers of tourists and business interests to the area.

- Resource Limitations.

The reverse side of the peculiar local climate is that it is also a climate of occasionally extreme wet and dry conditions that may last for several weeks.

The very wet winter climate conditions are known to have caused soil saturation and slope failures, overland sheet flow and stream flooding, severe storms and windthrow of forest stands, and the exposure of inhabitants and visitors alike to the dangerous physical conditions just indicated, as well as the life-threatening symptoms of hypothermia.

Conversely, the occasionally severe, long droughty summer conditions have repeatedly been the cause of drinking water shortages and high forest fire danger situations. Because the summer months are presumed to be the period during which the highest tourism traffic is likely to occur, it would appear to be quite rational to suggest that land managers and local business men address and resolve these and other similar limitations imposed by the climate, through mutually beneficial collaboration.

- Scientific Interest and Importance.

The only climatological station active within the national park reserve, is the Atmospheric Environment Service station situated at Cape St. James. Other climatic data were collected and presented formally by select researchers and certain other interested persons; however, these data were usually compilations of climatic data from all climatic stations operative on the archipelago.

It would appear from the information consulted, that the Atmospheric Environment Service is the only organization committed to and interested in collecting and recording primary climatic data. All other persons, institutions, and organizations, seem to use climatic data in a supporting role to their own specific research topics.

Even though the interest in climatic information is presently not as widespread as one might hope for or expect, the importance of such data to resource planners and park managers will increase in direct proportion to the increase in visitation and infrastructure development the national park reserve will experience during the next decade. As public transportation, law enforcement, environmental surveillance, and public safety and rescue programs begin to expand under public pressure, they will begin to demand "near real-time" climatic data in order to meet their political, social, economic, and legal obligations.

- Management Options / Alternatives.

There is a firm conviction that the option for resource managers of the national park reserve not to be actively supportive of climatic data gathering activities, is an untenable one. Therefore, it remains only to verbalize our commitment to the task ahead of us, and then select the most cost-effective alternative(s) to formally and actively support, supplement, and expand, as the case may be, the services presently provided by the Atmospheric Environment Service.

III. Water Resources

- Resource Capabilities.

The capability of the freshwater resources to support and sustain all forms of life and environmental processes, is linked directly to the patterns and vagaries of the modern climate within the South Moresby / Gwaii Haanas National Park Reserve and its climatic region. The prevailing maritime climate makes the Queen Charlotte Islands one of the wettest regions in Canada and finds expression in the abundance of streamflow, high lake levels, saturated soil conditions and groundwater reservoirs, during all but the summer months. In addition, the maritime water cycle experienced by the archipelago is known to have been very stable over long periods of time, and appears to remain so today.

- Resource Limitations.

As might be expected, the high precipitation pattern of the Islands also imposes some notable limitations that are often exacerbated by other environmental factors. For example:

1.) The presence of many large slope failures is the result of highly saturated soils in which the internal hydrostatic pressure has (a) caused them to fail under gravitational pull; or, (b) where seismic activity has caused them to become dislodged and catastrophically mobile.

2.) Winter storms have repeatedly dislodged and windthrown large sections of forest, especially on the steep and saturated slopes along the west coast of the archipelago.

3.) Evidence is common which provides indication of past storms with excessive amounts of precipitation that gave rise to conditions of repeated and often catastrophic stream flooding, particularly in the lower reaches of the drainages where the spawning beds of certain fish populations have been disrupted.

4.) Excessive overland sheet flows of rainwater have been reported, but their effects on the terrain, covering vegetations, and facilities like trails and structures, is not known at this time.

In almost all of the stated limitations, the probability exists that they have the potential to threaten human safety, especially as the managers of the park reserve begin to develop infrastructural facilities, thereby also attracting increasing numbers of park visitors.

- Scientific Interest and Importance.

While it is clear that certain groups of researchers, for example fisheries biologists, have shown interest in how the water resources might affect their particular endeavour and area of study, the available information would seem to indicate that the interest in the water resources themselves, has been and still is very limited to a small group of specialists.

On the other hand, the importance of the maintenance of water quality and the study of the local water resources in general seems to be understood and supported by many individuals and groups. One is left, however, with the conclusion that those factors of importance have not been translated into action. It is not known whether that situation exists as a result of lack of funding or the isolation of the areas requiring water resource inventories.

- Management Options / Alternatives.

The mandate of the Canadian National Parks Service stipulates that the natural resources of national parks will be studied, monitored, and managed in an ecologically sound manner. It can, therefore, be safely concluded that the issue of the management option for the water resources has already been decided.

The alternative to bring the mandated option about has not been chosen, but it would seem logical to initiate cooperative study and monitoring ventures between the personnel of the park reserve and that of the provincial and federal departments engaged in water resource work in the area. Such ventures could build on, continue, and expand past streamflow, sediment transport, and channel stability studies, and begin to obtain hydrometric data on snowfalls and snowpacks in the uplands. In addition, any alternative(s) chosen must include the provision to measure water quality.

IV. Geological Resources

- Resource Capabilities.

The geological resources provide the physical backdrop to the aesthetic character and quality ascribed to this national park reserve. The cloud-shrouded mountain ranges, glacially-carved fjords, and islets eroded by ocean waves, are known to provide a highly attractive appeal to most visitors to the area. This appeal, coupled with outstanding tectonic, petrologic, and palaeontologic features, has also attracted a select group of distinguished earth scientists who, over the years, have conducted extensive research on the archipelago. It is to their vast credit that we have any understanding about the geological resources today. Much of the information now available about the geology of the national park reserve will reach the visiting public through visitor service brochures and will find further expression in future endeavours of the park interpretive programs. It is believed that the capability of that information to enrich the experiences of park visitors is a notable one, with long-term and very personal benefits to segments of the visiting public.

The area of the park reserve has also been endowed with notable deposits of economically attractive minerals, and possibly some overmature hydrocarbon deposits. The search for and exploitation of these minerals have, since prior to the turn of the past century, contributed to the exploration, settlement, and economic well-being of the Queen Charlotte Islands. The capability role of the mineral resources to induce and support economic exploitations will change, as the mandate and policy of the Canadian Parks Service will be applied to the area encompassed by the national park reserve. However, the very presence of a multitude of different mineral resources and the existence of many a physical remnant of past periods of exploration, might be viewed as an actual bonus for future park interpretive visitor activities and historic site designations.

The presence of hydrogeothermal springs on one of the smaller islands within the national park reserve is believed to have been known to local inhabitants since prehistoric times, and is certainly seen as one of the major recreational attractions of modern visitors to the archipelago. That the surface flow rates of the springs appear to be very limited in amounts does not appear to have detracted from their popularity as a local bathing facility. Additionally, the subsurficial flow or storage chambers of the tectonically heated waters have given rise to the only geothermal meadow known to exist in Canada. The fact that the vegetation community of the meadow consists of a very limited number of temperature tolerant plant species makes it also a noteworthy site for botanical study.

- Resource Limitations.

The range of geological resource limitations covers a number of mostly physical processes and activities, some of which have the potential to create catastrophic events or conditions. For example, on-shore or off-shore seismic activity can occur with high frequency and sufficient force to be the cause of severe land slides, cave-ins, structural failures, and tsunamis; to mention but a few highly dangerous instances known to occur. There are a multitude of lesser geological events that have the potential to place limitations on park management and visitor activities alike.

The known occurrences of commercially valuable base metal ores within the national park reserve must also be viewed in the light of the "Memorandum of Agreement" between the Governments of Canada and the Province of British Columbia; which allows for the creation of "exclusion zones" for the purpose of mineral exploration. While it can be speculated that the reason for the continuance of such zones will eventually cease, in the meantime they are expected to demand considerable attention from the resource managers of the new national park reserve. The case in point being the commercial exploration activities of 1988 in the vicinity of Lockeport.

The hotsprings on Hotspring Island, must be regarded as only ephemeral geological features that may not warrant extensive associated facility development. Therefore, consideration must be given to the fact that, while the hotsprings have and are presently providing conditions for an enjoyable and quality recreational experience, one of the frequent, local and deep-seated earthquakes may at any time disrupt and redirect the flow of the geothermally heated waters away from their present surface outlets.

The presence of numbers of old and abandoned underground mine sites and large surface mine pits adds more than a touch of concern for public safety as more and more park visitors might use the opportunity to visit and explore the old surface and underground workings which, at this point in time, have not been marked "out-of-bounds" for public safety reasons. To a somewhat different and lesser degree, the same holds true for the few surface occurrences of liquid hydrocarbons which may or may not be accompanied by the venting of poisonous and highly flammable gases. The current level of knowledge among the personnel of the Canadian Parks Service about these matters is so limited as not to be currently useful to provide proper direction to resolve these concerns.

- Scientific Interest and Importance.

The geological resources of the Queen Charlotte Islands have for more than one hundred years attracted considerable interest in both the scientific and commercial communities. The natural occurrence of extensive exposures of fossil remains has significantly contributed to the establishment of fossil "type localities" and the general expansion of palaeontological knowledge about ancient world environments. Much the same can be said about the past scientific studies of coal, placer, and base metal deposits. Subsequent to the early interests in scientific knowledge, periods of commercial interests led to the eventual exploration and exploitation of many of the known coal, placer, and ore deposits, periods of local history which are still remembered as periods of boom and bust. More recently, the presence of offshore, and possibly nearshore or onshore, hydrocarbon deposits has raised considerable scientific and commercial interest.

The importance of geological phenomena to scientists and commercial resource exploitation companies remains considerable, especially as commodity trading on stock markets causes the prices of commercial geological resources to fluctuate with world requirements for such resources. Any substantial rise in the value of a geological commodity could, therefore, give rise to another period of resource exploration and exploitation in or near the national park reserve.

Finally, it is also of considerable importance to the Canadian Parks Service and its members serving in the South Moresby / Gwaii Haanas National Park Reserve, to secure a full understanding of all aspects of the broad local geological information base now available, and also establish provisions for:

(a) the acquisition of select geological data, as and when required for resource management purposes, and .....

(b) the selection of and support for specific geological research, aimed at acquiring new scientific data to raise the current levels of knowledge.

- Management Options / Alternatives.

For the foreseeable future at least, the options for the management of the geological resources within the national park reserve have been established through the "Memorandum of Agreement" and are, therefore binding until expiry of the agreement. The agreement thereby provides a potentially useful period of stability, during which the situation might arise through which future management options for the geological resources might be contemplated with a greater chance for success than is currently possible.

In the interim, and within the context of the agreement between the Governments of Canada and the Province of British Columbia, it is firmly believed that a variety of alternatives can be explored to begin to manage the geological resources, provide for their protection and preservation, and make provisions for park visitors to enjoy them in keeping with the national parks mandate. The preparation of the Park Management Plan, and eventually the preparation of a Geological Resource Management Plan, would go a long way to alleviate any concerns about the safekeeping and management of the geological resources of the park reserve.

V. Soil Resources

- Resource Capabilities.

Besides providing the most rudimentary comments about the capabilities of the local soil orders to support plants and their biomass production, to withstand some erosional impacts, and to absorb limited impacts of human use, too little is really known about the specific pedological characters and behaviours of the local soils within the national park reserve to provide any useful comments at this point. Perhaps a lesson can be learned from the observation that the regional climatic regime in combination with the local soils has, in almost every case, caused the signs of previous human activities to be masked, if not obliterated, by a vigorous vegetation cover of both native and introduced plant species. Since natural vegetation growth usually does not attain such a degree of vigour without the presence of a sufficiently deep and nutrient-rich soil base, the limited statement can be made that the local soils appear to be in equilibrium with their environment.

It is believed to be of the greatest importance to resource managers that the insufficient soil data base be enhanced through the initiation of a multi-year ecological land classification project which would, among other things, provide a technically sound overview of the local soil orders in their respective ecological setting. Only then, and after extensive field checking, can the capability of the soil orders be discussed with some degree of knowledge and authority.

- Resource Limitations.

Aside from citing obvious soil limitations brought about by saturated soil conditions, soil and subsoil failures on steep slopes, the effects of seismic activity, and the results of soil misuses, road construction, and logging, no more can be said about the full range of soil limitations than was possible for the statements about soil capabilities. Even then, most comments would be inferential, rather than be based on established fact.

There remains a substantial requirement to have all aspects of the pedological and technical characteristics of soils studied and described as soon as possible and in keeping with the Canadian System of Soil Classification, before resource managers are forced to make unalterable decisions about the disposition and use of local soils.

- Scientific Interest and Importance.

To date, there has not been a notable and sustained interest in soil science on the archipelago, except for perhaps a local interest in the somewhat limited agricultural areas on Graham island. Had it not been for certain foresters working for the British Columbia Forest Service and the major logging companies on the islands, and a very small number of botanically inclined scientists, next to nothing would be known about the soils of the Queen Charlotte Islands.

As the national park service becomes more firmly established within the area encompassed by the national park reserve on South Moresby Island, the value of and the need for scientifically obtained soil data will increase significantly in importance to the resource managers present. Add to this the recognized fact that facility and infrastructural developments, usually planned by engineers, have a high requirement for pedological information during the planning, construction, operation, and maintenance phases.

- Management Options / Alternatives.

Under the conditions described in the previous paragraphs, the only sensible option to pursue would be to recommend that every effort be made to launch an ecological land classification project at the earliest opportunity. Only in that manner will resource managers be provided with the ecologically integrated information from which to develop management alternatives that find support in factual data and are ecologically sound.

To manage and use the land and soils of the national park reserve without first acquiring such a comprehensive data base would leave the Canadian Parks Service subject to extended and intensive criticism from all Canadian shareholders.

VI. Vegetation Resources

- Resource Capabilities.

Had it not been for the description of the plant systematics by Calder and Taylor (1968), or the broad ecological interpretation of the vegetation and soils interrelationships by Banner *et al*. (1989), next to nothing would be known about the vegetation resources of the South Moresby / Gwaii Haanas National Park Reserve. They were in fact the first and the only fieldworkers to provide highly technical information about the botanical and ecological capabilities and limitations of the vigorous local vegetation communities and the soils that sustain them.

It is now known that the biomass productivity of the forest vegetation communities has been prodigious on most sites. It is also known that there exist distinct ranges of species presence and distribution, and the study of certain endemic species has given rise to the hypothesis of there having existed one or more refugia for plants and animals in the western mountains of the archipelago during past glacial times. However, beyond either, this very species-specific information or the much broader vegetation community interpretations and related inferences, there does not exist a data base of sufficient technical breadth or depth from which to provide resource managers with the capability to actually protect and manage species complexes, vegetation types, or whole vegetation communities.

The fact that resource managers in a national park require considerably more resource information than the works of the above-named scientists were intended to provide, does not minimize the value of their contributions in any way but, instead, places the onus squarely on the shoulders of the Canadian Parks Service to obtain the required information through a research project.

- Resource Limitations.

The limitations the vegetation communities present to the facility and infrastructural development so necessary in a new national park, can only be inferred from the limited information available to resource managers. Again, very little is known about the soil / vegetation interface within the area of the national park reserve, and the same can be said about the dynamics of local plant / animal communities.

Sufficient information is, however, available for resource managers of the Canadian Parks Service to recognize their responsibility to protect and preserve the unique, rare, and threatened plant species from destruction. Protection alone will set the stage for future studies to provide answers to the important questions of how plant dispersal across the Queen Charlotte Islands during early post-glacial times might have taken place, and where and what the presumed plant and animal refugia might have been. It is also known from observations and published records that the introduced black-tailed deer (*Odocoileus hemionus columbianus*) is seriously threatening the evolution of native plant communities and may, in fact, be a contributing factor to the eventual extirpation of one or more plant taxa. Undoubtedly, other threats to the ecological integrity of the native vegetation communities exist, but they have yet to be identified and described so that their limiting factors can be dealt with.

Observations have shown that exposed west coast forests are subject to massive windthrows during winter storms, when the anchoring soils are saturated by precipitation. The same conditions of soil saturation have been known to initiate the failure of some steep, forested slopes, with devastating results in the outrun zones at the bottom of valleys or along shorelines. There, the debris of such destructive natural disasters is deposited in unsightly mounds of plant, soil, and rock materials, that hinder travel, seriously obstruct and clog streams and their fish spawning beds, and present a serious threat to human life and any recreation facilities and structures.

- Scientific Interest and Importance.

Scientific interest in the native vegetation species and communities has remained high since the first days of European presence on the Queen Charlotte Islands, and reached its zenith with the monumental studies by Calder and Taylor (1968) and Taylor and Mulligan (1968). Few areas in Canada can lay claim to studies of similar depth and scientific intensity.

As excellent and valuable as the contributions of these earlier workers were, it is most important to have their information on the systematics and cytological aspects of vascular plants integrated into a yet to be developed ecological data base that will allow resource managers to develop ecologically sound management options.

- Management Options / Alternatives.

The preferred management option is to conduct an ecological land classification inventory project at the earliest opportunity, so that the presence and distribution of vascular and non-vascular species can be inventoried, described, and mapped in a well-established ecological framework.

Management alternatives to achieve the preferred option certainly exist, but all must be seen to begin with an approved set of Interim Management Guidelines that prescribe conservative management actions to protect the vegetation resources of the national park reserve from further impacts. New alternatives will present themselves quite naturally when the ecological vegetation inventory has been completed.

VII. Wildlife Resources

- Resource Capabilities.

Wildlife has always played a significant role in the ecosystems of the Queen Charlotte Islands, in the sustenance of human life, and more recently, in scientific study and the acquisition of knowledge. Among the various broad wildlife groupings present, birdlife has been categorized as one of the most outstanding natural resources of the region, even when terrestrial bird species usually characteristic in sub-alpine and alpine communities are absent, though suitable habitats exist on the Islands. Furthermore, Cowan (1989) described the mammalian fauna of the Queen Charlotte Islands as a depauperate fauna, lacking whole genera in some habitats, and noting the ecologically unbalanced situation between four native carnivore species and only one native rodent.

Seen from the recreational perspective of park visitors, the aesthetic setting of the area and region, in combination with the many opportunities to observe wildlife resources in their natural habitats, will surely serve to attract much of their attention. Park Interpreters and Visitor Services are presented with an ideal opportunity to provide park visitors with an enriching park experience.

- Resource Limitations.

Many of the perceived resource limitations relate directly to the past exploitation of native terrestrial wildlife species which has led to the extinction of some such species, and to the introduction of other and alien wildlife species. The ecological disruptions that those extirpations and introductions might have set in motion, are a topic of speculation. Serious studies are required to begin to understand the full impact on individual native species, their natural habitats, and their ecological interrelationships with other species.

The currently active studies on the effects of introduced predators on seabird colonies need to be expanded significantly and made to include all introduced species, whatever their impact. Without such very basic information and a vigorous monitoring program to follow up, resource managers will be unable to manage the full range of wildlife resources present, in keeping with the requirements of the national park mandate.

- Scientific Interest and Importance.

Broadly-based scientific interest in the terrestrial wildlife resources has, at best been spotty, and primarily revolves around the work of Foster, and Cowan and Guiguet in the 1960's. While their studies and documentations have laid a sound base for future enquiries, insufficient information is available to resource managers about the population dynamics and distributions of the various native or introduced wildlife species to begin to manage them with any hope of success.

The presumption is made that it is very important to science, and for that matter, resource managers, to study not only the biogeography of the national park reserve, but to expand such a study into:

(a) a full ecological investigation of the native wildlife species in relation to man's interference with them and their natural habitats;

(b) an investigation of the effects on native wildlife and their habitats, by the deliberate or accidental introductions of certain wildlife species alien to the Queen Charlotte Islands.

- Management Options / Alternatives.

Several options can be developed to address the presumed scientific and managerial requirements for better and expanded knowledge about the wildlife resources of the national park reserve. For the next few years, however, the "Memorandum of Agreement" between the Governments of Canada and the Province of British Columbia, must be viewed as the guiding document in the selection of practical management options.

It will be left to park managers to select the proper alternatives to achieve the prescribed option(s). As part of such a selection, it must be argued that the initiation of an integrated ecological land classification inventory project, at the earliest possible opportunity, ranks very high. Such an inventory would not only provide information about the presence and distribution of the various wildlife species, but more importantly, relate them to their actual ecological settings and roles within the island ecosystem.

VIII. Archaeological And Historic Resources

- Resource Capabilities.

Based on their cultural quality and uniqueness, the archaeological and historic resources of the Queen Charlotte Islands have, perhaps, attracted the most widespread attention over the past thirteen decades. In 1878, George Dawson initiated the first study of the life and culture of the Haida people. Many noteworthy scientists and historians have followed up his work, until there now exists a wealth of information about historic times. The same can not quite be said about prehistoric times, especially as they pertain to the remote region of South Moresby Island, where the national park reserve is located.

Sufficient basic archaeological and historical information is now available to park interpreters and visitor services personnel to develop a high quality public information program, especially so, if the Haida people were invited to participate in the presentation of the history of their culture.

- Resource Limitations.

The major weakness in the available data base, is the fact that while much is known about the history of the area encompassed by the national park reserve, much more remains to be researched and documented, before future park uses and developments obliterate and destroy any records of early human activity.

A more immediate limitation is the lack of park interpretive and visitor services facilities to present the known aspects of Haida cultural resources to the park visitors within the South Moresby / Gwaii Haanas National Park Reserve. This limitation includes the World Heritage Site on Anthony Island. However, the proposed construction of visitor information centres at the communities of Queen Charlotte City and Sandspit, and possibly at the yet to be initiated park staging area at Gordon Cove, may serve to alleviate some aspects of the previously stated limitations.

With the assistance of the world's UNESCO organization, it may be possible to foster a cooperative venture between the representatives of the Haida people and the Canadian Parks Service, that would both serve to protect and preserve the rich cultural heritage of Anthony Island, and yet make it available to the world community of man. This action by itself would go a long way to remove existing resource limitations.

- Scientific Interest and Importance.

Scientists and historians have long since demonstrated an intense interest in the uniqueness of Haida culture, and have thereby shown their belief in its importance to science and to the recorded history of mankind.

The expectation remains high that the representatives of the National Museums of Canada, the Royal Museum of British Columbia, and the professional archaeologists and historians of the Canadian Parks Service will continue to invest their time and effort in the study, documentation, and elaboration of Haida culture.

- Management Options / Alternatives.

Past and present worldwide interest in the archaeological and historical resources contained within the South Moresby / Gwaii Haanas National Park Reserve leaves the Canadian Parks Service with the management option that matches its own mandate perfectly; that is, to learn all that can be known and to protect and preserve those resources for the benefit of future generations of Canadians.

Meanwhile, and until the national park reserve has been declared a national park in its own right, every possible management alternative should be explored to foster long-term and cooperative research agreements with federal and provincial governments, as well as academic institutions.

VIV. Past And Present Land Use

- Resource Capabilities.

The opportunity exists to capitalize on areas that were previously affected by past and present resource uses, for the purpose of establishing future visitor service and park interpretive facilities, as well as to locate infrastructural developments. Such an approach would offer two-fold benefits: first, the reutilization of already disturbed terrestrial areas and thereby the rehabilitation of some past damages would be accomplished; and second, that reutilization and rehabilitation of already impacted areas would serve to protect pristine areas that might otherwise be disturbed. The Environmental Assessment & Review Process (E.A.R.Process) will be made to play a very important role during the site selection and project development according to its mandated application.

The completion of a Park Management Plan should serve to facilitate thoughtful and ecologically sound development of this national park reserve in an area that has, in part at least, already been subjected to severe environmental impacts by past human activities.

- Resource Limitations.

With the formal establishment of a national park reserve on South Moresby Island, all resource uses and exploitation activities have ceased, except for those mandated by the "Memorandum of Agreement" between the Governments of Canada and the Province of British Columbia. Future agreements and resource management requirements may bring about further curtailment of some resource exploitations.

Great care must be taken, while planning for and eventually constructing park facilities and infrastructural developments, that no archaeological or historical resources will be disturbed or damaged. The national parks mandate places severe limitations on any activities whatsoever with the potential to impair national heritage resources. Federal law makes it government policy that all activities on federal lands, and using federal funding, must first be checked through the implementation of the E.A.R. Process to assure that no significant environmental impacts might result, be they new developments or rehabilitation activities as a result of past impacts.

- Scientific Interest and Importance.

Aside from some social scientists, historians, and certain conservation groups represented by professionally trained individuals, the scientific community appears to have paid little attention to the larger issue of resource use and resource exploitation of the national park reserve. That is, other than in the context of the perceived environmental plight of the Queen Charlotte Islands as a whole.

That is not to imply that the scientific community did not recognize the importance of the emotionally charged debate about the use and exploitation of natural resources on the Islands. Far from it; but for the most part and to their credit, they maintained their impartially professional demeanour throughout the years leading to the declaration of the national park reserve.

- Management Options / Alternatives.

The limits of the immediate management options have already been declared by (a) the original acceptance of the "Memorandum of Agreement", and (b) the legally prescribed necessity to apply the federal Environmental Assessment & Review Process (E.A.R.Process) to either the development of new resource use, or the rehabilitation of past ones.

It is within the purview of local park managers to devise the actual management alternatives that comply with the mandated limitations, and stay within the approved management directions prescribed by the Park Management Plan.

X. Sensitive Resources

- Resource Capabilities.

The cursory analytical treatment so far afforded the natural ecosystems contained within the South Moresby / Gwaii Haanas National Park Reserve has already provided sufficient information to conclude that the area of the park reserve is endowed with a multitude of environmentally sensitive resources. Their aesthetic capability to attract park visitors is not in doubt, but that presumption must yet be weighed against their fragility and uniqueness values, and other somewhat similar value factors. However, because the listing so far of most sensitive resources was primarily extracted from printed documentation, and has not for the most part been field checked, it is too early to assume that it is either correct or complete.

- Resource Limitations.

The primary resource limitations would not appear to be entirely imposed by the sensitivity or environmental quality of each resource or site described, but much rather by the arbitrary and remote treatment the authors were forced to use, when visitation of the selected resources or sites became impossible.

It is fully expected that actual site visits and *in situ* resource analyses will remove most of the present limitations, as well as alter and/or lengthen the present listing.

- Scientific Interest and Importance.

On the basis that this form of mainly artificial and somewhat subjective resource enquiry is believed to be peculiar to the manner of planning of the Canadian Parks Service, one would not expect physical or social scientists to pay much attention to such in-house endeavours, except perhaps to foment argument after publication of the final list of selections.

- Management Options / Alternatives.

The most productive management option possible, that is in terms of lending more credibility to this peculiar endeavour, would be to argue for and promote an early plan to have the sensitive resources and sites field checked by a small team of qualified in-house professionals. The alternatives available to organize and achieve such a plan, will have to be left with the park management team of the South Moresby / Gwaii Haanas National Park Reserve.

XI. Ecological Trends

- Resource Capabilities.

In terms of their long-term ecological trends, the natural resources of the national park reserve are not well enough described or understood at this point in time so that their capabilities could be discussed in any meaningful way. The lack of a complete, up-to-date, and functional information base is the most important current issue for resource managers, and is one that underscores the requirement for an integrated ecological land classification at the earliest possible opportunity.

By contrast, the presently active ecological trends, even if poorly understood, appear to provide a wide variety of expansionary opportunities for the local human population and its socio-cultural and economic activities. Unfortunately, the widespread and often intensive human activities have been and are being conducted at the expense of the natural resources, and hence are surmised to have the capability to alter and interfere with ecological trends which provided for the expansionary opportunities in the first place.

- Resource Limitations.

While recognizing the fact that the ecological trends affecting the Queen Charlotte Islands are poorly understood, experience has taught that, if human activity ignores the need to maintain the environmental integrity of the living space in which it is conducted, ecological deterioration soon imposes stringent limitations on the human condition.

There is every reason to suspect that any deterioration of the ecological trends in the South Moresby / Gwaii Haanas National Park Reserve, would impose severe limitations on any park visitor or park management activities there.

- Scientific Interest and Importance.

So far, the scientific literature has no more than drawn basic attention to the issue and study of long-term ecological trends, and in spite of the generally acknowledged importance of the subject matter, no scientist appears to have found sufficient support to pick up the challenge.

- Management Options / Alternatives.

The only reasonable management option to be considered by the Canadian Parks Service is to initiate and then support an academic interest in this subject matter. Various alternatives present themselves, whether they be composed of a problem-specific study, or become part of a larger integrated ecological land classification inventory project.

B. MARINE RESOURCE EVALUATION

I. Regional Park Perspective

- Resource Capabilities

In terms of the ability of the proposed national marine park reserve to encourage and support increased levels of tourism, it is necessary to look at the conjunctive national park as well. While it is the marine elements of the area (marine wildlife, fishing opportunities, the fascinating shoreline and the ocean itself) which constitute the major attractions for tourism, it is a land-based infrastructure upon which that tourism depends. Indeed, the land-water interface provides the major focal point for tourist activity. Even the majority of the cultural heritage features of the area are within sight of the sea/land interface.

- Resource Limitations

Opportunities for public enjoyment and appreciation of the marine resource are limited by the fact that the support for such activity must be land-based (in the form of access points, camping areas, water supplies, docking facilities and service centres). A certain number of the visitors to the proposed marine park reserve - those in larger sea-going vessels - will be virtually self-sufficient. The managerial challenge with respect to those visitors will not be to provide for support, but will rather be to convey the message of the marine park reserve. The majority of visitors will be travelling in smaller craft such as sailboats, motor boats and kayaks for whom a certain amount of support will be essential if they are to experience all that the park reserve has to offer.

Two strong limitations to visitor enjoyment are posed by the very nature of the marine environment itself: the changeability and ferocity of the weather and the impenetrability of the ocean depths. That is not to suggest that submarine activity is not possible any more than the weather makes sea-surface activity impossible, only that specialized equipment is required to explore the area of the proposed marine park reserve beneath the surface of the ocean and that all visitors and staff must be wary of weather conditions.

- Scientific Interest and Importance

Until the introduction of the notion of park development, interest in terms of the tourism perspective on the Queen Charlotte Islands as a whole had been low, let alone interest in the southern area of Moresby Island. The Queen Charlotte Island Regional Economic Development Initiative has raised both the level of interest and the level of importance of the national park reserve and the proposed national marine park reserve in the regional perspective.

Given their largely migratory nature, the sizeable marine faunal populations (particularly with respect to avifauna and pinnipeds) are of distinct scientific interest and importance on a regional, national, and even international scale. Likewise, the young and dynamic geomorphology of the area has wide-ranging interest and importance, not only because of its distinctive nature, but because the consequences of its dynamism may be far-reaching.

From an archaeological and historical perspective, the Haida culture of the Queen Charlotte Islands represents one of the richest native traditions not only of the Pacific Northwest, but of the country and the Pacific Rim as a whole.

- Management Options / Alternatives

Management options or alternatives for the area of the proposed national marine park reserve are still very much in the developmental stage given the tentative status of the reserve and the yet immature infrastructure of the national park reserve. The fulfilment of the intent of the July 12, 1988 Memorandum of Agreement between the Governments of Canada and British Columbia, the fruition of the Regional Economic Development Initiative, the fulfilment of the mandate under the National Marine Park Policy, and the inclusion of other stakeholders such as the Haida, the Department of Fisheries and Oceans and the Department of Transport in the managerial process, all require the careful consideration of a range of managerial alternatives unencumbered by preconception. It would be imprudent to suggest management options without the advice of major interests in the Queen Charlotte Islands and adjacent waters in their regional context.

II. Regional Climate

- Resource Capabilities

While the function of the ocean as a heat sink has the effect of moderating the temperatures of the marine climate of the Queen Charlotte Islands, wind patterns remain both changeable and fierce. Marine flora and fauna flourish in the temperate, moist climate. The relatively dry and somewhat protected east coast of the islands affords a climate more suited to settlement and transportation.

- Resource Limitations

The relatively high rainfall and strong, variable wind conditions common to the western coast of the Queen Charlotte Islands tend to render the west coast less favourable to human travel and habitation than the drier, more sheltered east coast. The seasonal precipitation extremes of high winter rainfall and summer drought pose restrictions for both visitors and staff of the reserve.

- Scientific Interest and Importance

The climatic factor has the ability to influence visitor use patterns and visitor safety as well as management activities and personnel safety in a highly dynamic manner. Given the great importance of accurate, precise and contemporary meteorological information, the interest in marine weather patterns and conditions deserves to be higher than it has been in the past.

- Management Options / Alternatives

To meet its responsibilities to the public and park service staff, the Canadian Park Service must actively support meteorological data collection. Whether that is done by augmenting or supporting the efforts of the Atmospheric Environment Service (or both) can be decided once the commitment is made.

III. Oceanography

- Resource Capabilities

The deeply crenulated and sheltered eastern coast of the Queen Charlotte Islands supports a wealth of marine fauna and lends itself readily to a variety of human activity with some seasonal restrictions due mainly to the influences of climate. The temperate submarine environment surrounding the Queen Charlotte Islands is inhabited by a diverse, abundant and largely mobile faunal population.

- Resource Limitations

Inasmuch as waves, tides and currents tend to undergo some seasonal fluctuations in response to climatic patterns, oceanographic limitations are similar to those of climate. Greater caution and some restriction of activity is necessary in winter. As well, the more exposed west coast poses more limitations than does the more sheltered eastern coast.

Tsunamis, seismic sea waves, are an oceanographic phenomenon generated by a geological event. The possibility of their occurrence represents a cautionary limitation rather than a restrictive limitation to human activity in the marine environment.

The nature of the ocean itself as an environment hostile to man poses limitations to travel, survival and management. Travel is restricted to those with the access to and knowledge of the special equipment and skills. Even with specialized equipment and abilities, there are restrictions as to the depth and duration of human survival in the submarine environment. As a consequence of the limitations imposed on human travel and survival in the submarine environment, the acquisition of knowledge of the resources of that environment suffers the limitation of being both an expensive and time-consuming undertaking.

- Scientific Interest and Importance

Oceanographic conditions work hand in hand with climatic conditions to pose important influences on the abilities of visitors and staff alike to live, travel and work safely in the marine environment. As with meteorological information, oceanographic data is most valuable to managers if it is accurate, precise and contemporary. Whereas the history of oceanographic data gathering has been spatially and temporally sporadic, it takes on a more pressing importance in light of the development of the national park reserve and the national marine park reserve.

- Management Options / Alternatives

Quite apart from the mandate of the Canadian Parks Service to engage in ecologically sound management of park resources, there is an obligation to public and staff from a public safety standpoint alone to provide information on oceanographic conditions. There is the option to augment or support the efforts of the Canadian Coast Guard and the Department of Fisheries and Oceans in fulfillment of those responsibilities

IV. Geological Resources

- Resource Capabilities

While the terrestrial and marine geologies of the Queen Charlotte Islands are identical in terms of their origins, millennia of submersion of the marine geological resources have rendered them distinct in terms of their present-day capabilities. The marine geological resources are far more subtle a backdrop to the aesthetic character and quality of the proposed national marine park reserve than are the terrestrial geological resources to the national park reserve. The marine geological resources include mineral endowments similar to those of the terrestrial geological resources, but their distribution is less well documented. The presence of economically viable hydrocarbon deposits is as yet a matter of speculation.

- Resource Limitations

The proximity of the Queen Charlotte Islands to the tectonically active margin between the Pacific Plate and the North America Plate renders the area the most seismically active in Canada. Such frequent seismic activity results in the generation of submarine slides and Tsunamis which can have serious consequences for public and staff safety.

The Memorandum of Agreement between the governments of Canada and British Columbia by which the national park reserve was initiated, includes a provision which allows for the creation of exclusion zones for the purposes of mineral exploration within the proposed national marine park reserve. While the difficulties posed by the extraction of a submarine resource are such that any marine exclusion zones are more unlikely than their terrestrial counterparts, the possibility exists nonetheless. Offshore hydrocarbon exploration and development in the area is presently halted under the terms of a moratorium renewed for 5 years in 1989.

- Scientific Interest and Importance

The high degree of seismic activity in the area (both as to frequency and intensity) renders it important as a locality of scientific interest. The proximity of the Queen Charlotte Fault to the west coast of the Queen Charlotte Islands affords the opportunity to study the submarine effects of tectonic movement with greater facility than is normally possible.

Though the presence of commercially viable hydrocarbon deposits in the region, particularly in the area of Hecate Strait and Queen Charlotte Sound, is unconfirmed, there has been considerable scientific and commercial interest in further exploration.

Though the major marine topography is charted, the detail is often missing except in selected localities. The region is less thoroughly charted than are some of the more travelled sections of the coast of British Columbia.

- Management Options / Alternatives

For the duration of the Memorandum of Agreement between the governments of Canada and British Columbia, geological resource management options are set in terms of allowing for mineral exploration and development. That should not impede managers from exploring the range of resource management possibilities which would be available following the attainment of national marine park status. It behooves the federal government as well to encourage that the current moratorium on marine hydrocarbon exploration be extended.

The Canadian Parks Service can work with the Canadian Coast Guard to encourage mariners to file Marine Information Reports for all of their un-charted observations, and the Canadian Hydrographic Service can be encouraged to up-date and expand their chart coverage of the region as marine traffic increases.

As SCUBA diving becomes more popular in the vicinity, it will be important for recreationists to have a detailed description of the bottom features to the limits of recreational diving. As a matter of both information and safety, the detailed charting of the shallow depths should be an early objective.

V. Soil Resources

- Resource Capabilities

The marine surficial sediments of the Queen Charlotte Islands vicinity are a rapidly dynamic resource. Sediments derived from the continual erosion of the adjacent landmass move quickly down-slope by virtue of the narrow Continental shelf and steep Continental slope. Submarine channels in the wider sections of the Continental shelf also allow downward sediment transport to proceed easily. The steep shoreline and strong wave action common to the west coast of the Queen Charlotte Islands tend to mitigate against sediment accumulations, much as the more shallow slopes and sheltered nature of the eastern shore tend to promote sediment accumulations.

- Resource Limitations

Marine sediments by their dynamic nature do not lend themselves to the lasting establishment of structures such as dock facilities unless it is in the most sheltered, shallowly-sloping locality. Moreover, the frequent seismic activity of the Queen Charlotte Islands region has the ability to initiate catastrophic sediment transport.

Frequent changes in the marine substrate pose limitations for navigation as well. Particularly in shallower waters, vessel traffic must be constantly wary of the fact that the charted depths can change more rapidly than hydrographic revisions can keep up with them. Vessels themselves disturb the substrate with anchoring manoeuvres.

- Scientific Interest and Importance

The deep sedimentology which illustrates geologic history has been of interest largely in the context of hydrocarbon exploration. The rapidly dynamic surficial sediments have been studied infrequently and on a localized basis. They deserve our abiding attention for their ability to rapidly modify the marine topography in a way that can have consequences for marine traffic.

- Management Options / Alternatives

Any marine-based structures, such as docks, will want careful consideration of the foundations as the surficial sediments of the shallow waters are little studied and quite changeable.

As interest in submarine exploration becomes a more popular recreational pastime, it will be important to divers to know the areas where unstable slopes can be anticipated and thereby avoided. The charting of such localities deserves early consideration in the course of the marine biophysical inventory.

The Canadian Parks Service can work with the Canadian Coast Guard to encourage mariners to file Marine Information Reports for all of their uncharted observations, and the Canadian Hydrographic Service can be encouraged to up-date and expand their chart coverage of the region as marine traffic increases.

VI. Vegetation Resources

- Resource Capabilities

Highly productive marine wetlands are found throughout the Queen Charlotte Islands, particularly along the sheltered, much incised east coast. Their luxuriant vegetation provides both food and cover to many wildlife species, most notably the marine avifauna.

Marine algae supply both habitat and food source to numerous marine fauna. In the case of the kelp, there exists the capability to support a re-introduction of the sea otter which once thrived in the region. Kelp beds supply spawning grounds for herring, thereby supporting both a natural and an artificial roe-on-kelp fishery. The ability of marine algal populations to support a commercial harvest without sustaining irreversible damage, is as yet uncertain.

Shoreline vegetative communities harbour a range of wildlife species (both marine and terrestrial) which make use of the rich sea/land interface as a foraging area and/or as habitat.

- Resource Limitations

There is a limit to the number of wildlife that the estuarine environments of the Queen Charlotte Islands can support. As dyking, log storage, landfill, dredging and pollution take their toll on the estuaries of the British Columbia coast, healthy wetlands, such as those in the area of the proposed national marine park reserve, become all the more important.

Large kelp beds, of the kind required to support a healthy sea otter population, are few in the area. Their success is inhibited by sea urchin herbivory.

Parts of the shoreline vegetation communities are undergoing gradual changes with the slow diminution in the numbers of drift logs being washed up on the beaches.

- Scientific Interest and Importance

While the importance of the marine wetlands of the proposed national marine park reserve is recognized, detailed study of those wetlands has been sporadic. And though it is recognized that changes in the availability of drift logs will change some vegetative shoreline communities, those changes are not being monitored in the area as of yet.

There is a great deal of interest in the re-introduction of the sea otter into the area, something which also implies a re-introduction of large kelp beds.

- Management Options / Alternatives

The marine wetlands of the proposed national marine park reserve deserve careful, early attention in the marine biophysical inventory. Not only should the vegetation communities be mapped, but their success should be monitored, particularly in the vicinity of high visitor traffic or facility development. The same is true of shoreline communities, since those will be most vulnerable to visitor impact. A special effort to study the extent and distribution of kelp communities if the re-introduction of sea otter is considered.

While submarine vegetation is less vulnerable to human impact as a rule, anchorages are a special exception to that rule. Managers may wish to consider the option of establishing permanent floats in certain popular anchorages in order to diminish the impact to the substrate and its floral and faunal inhabitants.

VII. Wildlife Resources

- Resource Capabilities

The marine fauna of the Queen Charlotte Islands is far richer than its terrestrial counterpart both in terms of numbers of species and population numbers. The benthic invertebrate population and the marine fish populations support commercial, sport, and native food fisheries. The marine waters of the Queen Charlotte Islands are home to some 315 species of fish alone.

Though the number of marine avifaunal species is low (about 22), the population numbers are quite high. Over 1.5 million seabirds breed at almost 200 sites in the Queen Charlotte Islands each year.

At least 26 species of marine mammals are known or expected to occur in the Queen Charlotte Islands. For some species, notably the killer whale and the steller sea lion, the marine environment of the Queen Charlotte Islands represents a vital part of their known distribution. The Queen Charlotte Islands were once home to a thriving population of sea otters as well, and the potential exists to re-introduce the species into its former range.

- Resource Limitations

Harvesting pressures and facility development can threaten the viability of certain of the invertebrate and fish populations. In the case of migratory fish populations, pressures on the population outside of the reserve area are largely unmanageable. That is not the case for fish populations and benthic invertebrate populations within the boundaries of the proposed national marine park reserve.

Marine avifaunal numbers are restricted by available habitat, human disturbance and predation. The effects of predation by raccoon (which were introduced to the Queen Charlotte Islands) are under study. The fact that breeding marine avifaunal populations are largely restricted to smaller offshore islands and rocks may be due in large part to the fact that they are safer from predation in those locations than they would be on the larger islands.

Historic harvesting pressures on marine mammal populations in the Pacific Northwest are now mostly absent. But the same is not true in international waters. Certain of the cetaceans face the risk of elimination. The once plentiful sea otter was extirpated from the Queen Charlotte Islands under hunting pressure. Re-introduction of the species today is rendered the more difficult because the favourite prey of the sea otter, the sea urchin, has increased in number to the point that it has eliminated most of the once wide-reaching kelp beds that are the preferred habitat of the sea otter

- Scientific Interest and Importance

Study thus far has turned up eight endemic, rare, or endangered fish species in the marine waters of the Queen Charlotte Islands. Scientific study has typically concentrated on the important commercial species with the result that very little is known on a local basis of the numerous non-commercial species. The situation for benthic invertebrates is similar. Endemic, rare, or endangered invertebrate species have not been identified.

In the case of the marine avifauna, for some species, the Queen Charlotte Islands population is the majority of the British Columbia population, and for many more, the Queen Charlotte Islands represent a critical habitat for one or more stages of the annual migration. Important studies are underway to determine the interactions between seabirds and their introduced predators such as raccoons and rats.

Several species of marine mammals found in British Columbian waters are under pressures due to hunting, loss of habitat and reduction of food supply which have rendered their numbers declining or their status threatened. Their protection and the protection of their habitats within British Columbian waters becomes all the more important in light of their global status. The Steller sea lion colony at Cape St. James is particularly important to the specie in terms of the health of the global population. The waters of the Queen Charlotte Islands take on tremendous importance to certain of the migrating cetacea as well. Over the course of a year, nearly the entire eastern Pacific population of gray whales transits those waters. And scientific interest is high in the possibility of re-establishing the once-plentiful sea otter in the Queen Charlotte Islands. The proposed national marine park reserve would provide an ideal situation in which to restore the sea otter as an important component of the coastal marine ecosystem.

- Management Options / Alternatives

Under the terms of the National Marine Park Policy, management of the marine faunal resource must be undertaken in cooperation with other regulatory agencies in order to encourage compatible coastal and aquatic uses in surrounding areas. The principal cooperating agency in this case is the Department of Fisheries and Oceans as fishing is to continue in national marine parks, subject to protecting the ecosystem, maintaining viable fish populations and attaining the purposes and objectives of the park. It is important that, in the National Marine Parks Policy, as under the terms of the Fisheries Act, the term fish is used to mean fish, invertebrates, marine mammals and marine plants. It is important that the Canadian Parks Service be able to present a knowledgeable case for the preservation of native marine faunal species in joint deliberations over the management of faunal resources. The mandate is clearer in the case of the unilateral management of the marine avifaunal resources by the Canadian Parks Service. But whether faunal resources are managed unilaterally or multilaterally, there is a need for more detailed, current information on the local distribution and habits of marine fauna. Inventory information on marine fauna is both time-consuming and expensive to gather. The earlier the process of improving our knowledge base is undertaken, the better managers will be able to make informed decisions regarding marine fauna and their habitat.

VIII. Marine Archaeological And Historical Resources

- Resource Capabilities

The cultural remnants of Haida occupation which exist along the marine shoreline are an extension of the rich terrestrial cultural resource of the Queen Charlotte Islands. While the literature currently describes 13 marine-associated archaeological sites in the area of the national park reserve and proposed national marine park reserve, more may be uncovered in the course of a comprehensive marine archaeological inventory.

Sites of historic shipwrecks within the waters of the proposed national marine park reserve are even fewer than are the artifacts of Haida occupation. Seven shipwrecks are briefly described in the literature. While the coast of the Queen Charlotte Islands has been less thoroughly travelled than other parts of the British Columbia coast, a marine archaeological inventory will undoubtedly discover heretofore unrecognized wrecks.

- Resource Limitations

The same limitations which apply to terrestrial archaeological resources - a weak data base and a lack of the visitor services and interpretive facilities to present the archaeological and historic message - apply to the marine archaeological and historic resources as well. In addition, the nature of the marine environment presents significant limitations for discovery and interpretation. Safety, accessibility, and the fragile nature of marine archaeological and historic resources, dictate that they be appreciated remotely. Even the exploration of some of the deeper marine reaches is better undertaken with a remote observational vehicle.

- Scientific Interest and Importance

While the marine-associated sites may represent only a small part of the archaeological resources depictive of the ancient Haida culture, the importance of the marine environment and its resources in that culture make such sites of great scientific interest. Indeed, the fact that such sites are relatively scarce (compared to terrestrial sites) adds weight to their importance.

In the case of historic shipwrecks, too, the very paucity of the record lends additional significance to each wreck as an important part of the historical account of the region.

- Management Options / Alternatives

The protection and preservation of valued cultural resources has a justifiably high priority in the mandate of the Canadian Parks Service. The protection of those resources can best be accomplished by first learning all that can be known about them. The challenge is to do so while preserving the cultural integrity of those resources. The difficulties of access and preservation in a marine environment are an additional challenge.

IX. Marine Resource Use

- Resource Capabilities

The marine fishery is the largest of the marine resources subject to use. An historic native food fishery has been joined by a large commercial fishery and a small but growing sport fishery in the waters off the Queen Charlotte Islands. The fishery extends to invertebrates, pelagic fish, anadromous fish and bottom fish as well as certain marine vegetation. Petroleum and mineral extraction have only recently been contemplated, but no effort has been made at marine mineral exploration, and there is a moratorium at present on the exploration and development of as yet unproven submarine oil resources. The use of the marine environment for transportation and recreational purposes is a rapidly-growing, non-extractive use of the marine resource.

- Resource Limitations

The ability of the various marine fisheries to support increasing harvesting pressures is limited. Certain fish stocks are already diminishing under both domestic and international pressure. The amount of giant kelp in the area, already limited by increased grazing pressure from the sea urchin which is no longer under control by the sea otter, is further diminished by harvest for the growing roe-on-kelp fishery. The harvest of kelp to feed a kelp processing plant in the area (a scheme which has been started and abandoned already) would further restrict kelp beds. Mineral extraction is not yet considered economically feasible in the marine environment, but the only thing which is preventing renewed petroleum exploration is a government moratorium on the activity in British Columbia waters. The existence of an economically extractable petroleum resource is as yet a matter of speculation. Use of the marine environment for transportation and recreational purposes is limited by the availability of suitable anchorage and navigable channels. The harsh nature of the marine weather on the west coast of the Queen Charlotte Islands poses its own additional restrictions.

- Scientific Interest and Importance

Scientific interest in marine resource use concentrates largely on the fish and invertebrate species subject to a commercial or sport fishery. Few endemic, rare or endangered species have been identified as yet. Very little work has been done on the native food fishery. Scientific interest in marine vegetative resource use will likely grow as the world population grows and we endeavour to discover more and cheaper sources of nourishment.

There is a strong international interest in the cetacean species which are not subject to hunting nationally, but are under severe pressures in international waters.

Oil exploration having shown in the past that the potential exists for the existence of exploitable oil resources beneath Hecate Strait and Queen Charlotte Sound, there is a good deal of scientific industrial interest in further pursuing that exploration.

- Management Options / Alternatives

Management of the marine fishery is necessarily a cooperative effort with the Department of Fisheries and Oceans. Management of marine traffic, both recreational and otherwise, must be undertaken in conjunction with the Department of Transport. Mechanisms and agreements for the joint management of such resources should be negotiated at the earliest opportunity so that permissible marine resource use can be balanced with the preservation of those same resources.

The extension of the existing moratorium on offshore oil exploration and development will mitigate against the threat of oil pollution from wells in the waters outside of the proposed national marine park reserve.

X. Sensitive Marine Resources

- Resource Capabilities

The sensitive marine resources of the proposed national marine park reserve are far from completely identified. The majority of those identified to date relate to floral and faunal habitats. The listing of sensitive archaeological and historical resources in particular, needs to be expanded once the information base is improved.

- Resource Limitations

Appreciation, understanding and protection of sensitive marine resources is limited by the difficulties of access. Much of the sensitivity of marine resources relates to seasonal habitation by flora and fauna. That seasonality wants a more thorough understanding if the true nature of marine resource sensitivities are to be considered in management decision-making.

- Scientific Interest and Importance

The proper identification of sensitive marine resources is important not only to the success of Canadian Parks Service management endeavours, but to the continued understanding of those sensitive resources by the scientific community as a whole.

- Management Options / Alternatives

In order to lend credence to what, up to this point, has been an identification of sensitive resources based on the available literature, an early on-site reconnaissance needs to be made of the identified localities and other possible locations of sensitive resources. The need for protection or conservation measures can then be addressed on the basis of site-specific knowledge.

XI. Ecological Trends

- Resource Capabilities

Major ecological trends include a decline in commercially fished species, a continued threat of seismic activity and thereby Tsunamis, a reduction in the drift log barrier along the foreshore, continued sediment deposition downslope and into submarine channels, diminution of the giant kelp population under grazing pressure by sea urchin, reduction in cetacean, pinniped and seabird populations largely due to outside influences, increased pressure on the fishery resource, and a steady increase in the importance of sensitive resources as human activity impacts more heavily on such resources elsewhere in the British Columbia Coastal region.

- Resource Limitations

The identified ecological trends are largely detrimental to the natural resource base and thereby to the marine environment and all of those organisms which occupy that ecosystem, including mankind.

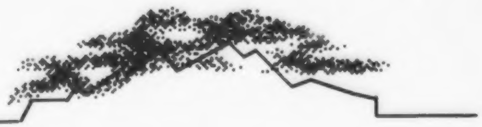
- Scientific Interest and Importance

Long-term ecological trends are all the more important scientifically for their being difficult to identify, particularly on the basis of so sparse and contemporary a knowledge base as we now have. The effort required in both time and money to study such trends discourages that very study.

- Management Options / Alternatives

The Canadian Parks Service can play a valuable role in serving as the initiator or coordinator of research efforts to determine the nature and extent of marine resource trends. Such efforts must necessarily be long-term themselves in order to distinguish environmental trends from seasonal and cyclical fluctuations.

RESOURCE MANAGEMENT OBJECTIVES



A. TERRESTRIAL OBJECTIVES

Based on the foregoing and provisional description, analysis, and evaluation of the natural resources contained within South Moresby / Gwaii Haanas National Park Reserve, it follows logically that broad, provisional Resource Management Objectives should be derived for the park reserve from the above-described planning activities.

In keeping with the national park mandate, as expressed through the National Parks Act and its Regulations, as well as the National Park Policy, following are five *terrestrial* Resource Management Objectives which are considered to be essential to guide the management of this new national park reserve into the foreseeable future:

- Objective 1, **Landscape Resources.**

- **All landscapes and soils will receive the levels of protection and preservation required to retain their natural state as a representative part of Natural Terrestrial Region 1.**

- **The highest levels of protection and preservation will be afforded those resources and processes which:**

(1) are nationally and internationally significant;

(2) are unique, rare, or endangered within the national park reserve;

(3) are representative examples of the natural resources and processes of Natural Region 1; and . . . .

(4) are important in the retention of the park reserve's wilderness character and general appeal to the visiting public, and meet the requirements of the "Memorandum of Agreement".

- **Where land use has the potential to modify the natural state of these resources adversely, use and development proposals must not exceed known, inherent limitations. This is to be accomplished by:**

(1) the utilization of land and soil units with no or fewer limitations; or . . . .

(2) where this is not possible, by modifying the land use and development proposals so that they incorporate the said resource limitations.

- Objective 2, Freshwater Resources.

- All freshwater resources and the physical shape of their basins and channels will be protected from impairment and manipulation until the information base for those resources has been sufficiently broadened and improved, so as to allow environmentally sound resource management to occur if and when necessary.

- When the information base has been sufficiently broadened to allow the development of specific management criteria, operational Resource Management Plans will be formulated.

- In the interim period, a Freshwater Resource Monitoring Program will be developed which will document and assess both, climatical and hydrological trends, and any man-made interference with the natural processes.

- Objective 3, Biotic Resources.

- Vegetation :

- All native vegetation will be afforded the full protection measures possible under the existing federal and provincial legislations.

- The special status of representativeness, uniqueness, or rarity of certain species, vegetation associations and habitat types within the flora of the national park reserve , require predetermined protection measures to assure their integrity and perpetuity.

- Where visitor use and proposed facility development may have an adverse impact on the vegetation resources designated with a special status, such activities will be redirected to vegetations and habitat types:

(1) without the special status designation, and therefore are less susceptible to such impacts; or . . . .

(2) are more commonly found in the national park reserve, the natural region, and elsewhere in the national park system.

- Wildlife :

- All native wildlife will be afforded the full protection measures possible under the existing federal and provincial legislations.

- The future role of introduced wildlife species within the national park reserve will be determined prior to gazetting it as a national park.

- Wildlife habitats identified as essential to the survival of certain species, will be assigned the highest degree of protection, surveillance and monitoring.

- Where proposed land use and facility developments have the potential to affect one or more aspects of the native wildlife or their habitats adversely, such proposals must not exceed the known and inherent wildlife and habitat limitations. This will be accomplished by:

(1) the utilization of land units with no or fewer resource limitations; or . . . .

(2) where this is not possible, by modifying the land use and development proposals so that they incorporate the known resource limitations.

- Objective 4, Human Heritage Resources.

• All archaeological and historical sites, artifacts, records, and similar resources will receive total protection from impairment, development, and exploitation until their cultural importance and significance have been established by competent researchers, and the directions for their protection, preservation, and management have been firmly established.

- Objective 5, Resource Utilization.

• Resource Management Plans will be formulated to provide environmental guidance for visitor use and recreational facility development proposals, so that such activities will not exceed the known, inherent resource limitations, and are consistent with the approved public safety standards.

• Such plans will incorporate requirements for active resource monitoring , so as to:

(1) keep the selected management options current in the light of changing recreational trends;

(2) evaluate the effectiveness of such plans; and . . . .

(3) assess the resulting environmental trends.

• Consumptive resource uses will be minimized or eliminated wherever possible.

• Site-specific resource studies and/or environmental impact assessments will be initiated prior to approval in principle of any proposals for land use and facility developments.

• Various forms of air, water, and soil pollution arising from resource utilization activities are incompatible with the resource management aims of national parks and will, therefore, be radically controlled, reduced, or eliminated wherever possible.

B. MARINE OBJECTIVES

In keeping with the national marine park mandate, as expressed through the National Parks Act and its Regulations, as well as the National Marine Park Policy, the following are five *marine* Resource Management Objectives intended to guide the management of the proposed national marine park reserve into the foreseeable future:

- Objective 1, **Marine Substrate Resources.**

- **All submarine landscapes and soils (sediments) will receive the levels of protection and preservation required to retain their natural state as a representative part of Natural Marine Regions 1, 2, and 3.**

- **The highest levels of protection and preservation will be afforded those resources and processes which:**

  (1) are nationally and internationally significant;

  (2) are unique, rare, or endangered within the national park reserve;

  (3) are representative examples of the natural resources and processes of Natural Regions 1, 2, and 3; and . . . .

  (4) are important in the retention of the park reserve's wilderness character and general appeal to the visiting public, and meet he requirements of the "Memorandum of Agreement".

- **Where marine resource use has the potential to modify the natural state of these resources adversely, use and development proposals must not exceed known, inherent limitations. This is to be accomplished by:**

  (1) the utilization of marine areas with no or fewer limitations; or . . . .

  (2) where this is not possible, by modifying the resource use and development proposals so that they incorporate the said resource limitations.

- Objective 2, Oceanographic Resources.

- All saltwater resources and the physical shape of their sounds, inlets, bays channels and estuaries will be protected from impairment and manipulation, until the information base for those resources has been sufficiently broadened and improved, so as to allow environmentally sound resource management to occur if and when necessary.

- When the information base has been sufficiently broadened to allow the development of specific management criteria, operational Resource Management Plans will be formulated.

- In the interim period, a Saltwater Resource Monitoring Program will be developed which will document and assess both, climatic and oceanographic trends, and any man-made interference with the natural processes.

- Objective 3, Biotic Resources.

- Vegetation:

- All native marine vegetation will be afforded the full protection measures possible under the existing federal and provincial legislations.

- The special status of representativeness, uniqueness, or rarity of certain species, vegetation associations and habitat types within the flora of the national marine park reserve, require predetermined protection measures to assure their integrity and perpetuity.

- Where visitor use and proposed facility development may have an adverse impact on the vegetation resources designated with a special status, such activities will be redirected to vegetations and habitat types:

(1) without the special status designation, and are therefore less susceptible to such impacts; or . . .

(2) more commonly found in the national marine park reserve, the marine natural region, and elsewhere in the national marine park system.

- Wildlife:

- All native marine wildlife will be afforded the full protection measures possible under the existing federal and provincial legislations, recognizing that fishing activity will continue within the national marine park reserve.

- The future role of of introduced wildlife species within the proposed national marine park reserve will be determined prior to gazetting it as a national marine park.

- Wildlife habitats identified as essential to the survival of certain species, will be assigned the highest degree of protection, surveillance and monitoring.

- Where proposed marine resource use and facility developments have the potential to affect one or more aspects of the native wildlife or their habitats adversely, such proposals must not exceed the known and inherent wildlife and habitat limitations. This will be accomplished by:

(1) the utilization of marine areas with no or fewer resource limitations; or ...

(2) where this is not possible, by modifying the resource use and development proposals, so that they incorporate the known resource limitations.

- Objective 4, Human Heritage Resources.

• All archaeological and historical sites, artifacts, records, and similar resources, will receive total protection from impairment, development, and exploitation, until their cultural importance and significance have been established by competent researchers, and the directions for their protection, preservation, and management, have been firmly established.

- Objective 5, Resource Utilization.

• Resource Management Plans will be formulated to provide environmental guidance for visitor use and recreational facility development proposals, so that such activities will not exceed the known, inherent resource limitations, and are consistent with the approved public safety standards.

• Such plans will incorporate requirements for active resource monitoring , so as to:

(1) keep the selected management options current in the light of changing recreational trends;

(2) evaluate the effectiveness of such plans; and . . .

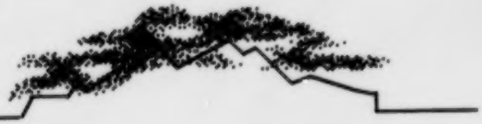
(3) assess the resulting environmental trends.

• Consumptive resource uses will be minimized or eliminated wherever possible.

• Site-specific resource studies and/or environmental impact assessments will be initiated prior to approval in principle of any proposals for marine resource use and facility developments.

• Various forms of air, sea, and substrate pollution, arising from resource utilization activities, are incompatible with the resource management aims of national parks and will therefore be radically controlled, reduced, or eliminated wherever possible.

RESOURCE MANAGEMENT REQUIREMENTS



- Introduction

With the completion of the descriptive and evaluative parts of this document, and following the stating of the provisional resource management objectives for the South Moresby / Gwaii Haanas National Park Reserve, it remains to describe the most obvious *Resource Management Requirements* that were noted. It is expected that their stating here will serve as the impetus from which the Natural Resource Conservation personnel of the national park reserve will prepare the next step of the Natural Resource Management Process; *ie.*, the ***Park Conservation Plan*** (Anon. 1979d).

Initiation of Integrated Ecological Land Classification Inventories.
The most pressing current resource management requirement is for independently produced, integrated ecological land classification inventories, for both, the terrestrial and marine environments of the national park reserve. These inventory studies would provide the primary resource data base, without which no land management activities nor facility developments should be undertaken.
The urgency for this requirement can not be overstated!

Initiation of a Long-Term Environmental Monitoring Program.
The most cost-effective method of improving the very limited resource data base of the national park reserve, is to initiate forthwith an all inclusive, long-term, and high technology-oriented natural resource monitoring program. This approach would tend to (a) provide the very base from which resource managers might plan their activities, (b) reduce inefficient manual data collections and analyses, (c) increase scientific validity of the data collected, and (d) provide an early warning system for such potential problem areas as coastal pollution, soil degradation, public safety issues, etc.

Development of a Land Use Strategy.
The need to accommodate park-related activity and facility developments, transportation infrastructures, aerial access, construction material extractions, stream manipulations, liquid and solid waste management and disposal, overland public utility services, and other more general land uses by park visitors, concessionnaires, and park managers, makes the development of a comprehensive and long-term land use strategy most desirable, if not imperative.

Development of an Ocean Use Strategy.
Several of the potential requirements listed under the Land Use Strategy also apply to planning the environmentally sound, park-related use of the ocean; that is, in addition to the necessity to address the concerns about the various potential impacts of national and international marine access, marine oil spills, marine landing rights, marine support facilities, commercial fisheries, hydrocarbon exploration and exploitation, etc. Again, the development of a comprehensive and long-term ocean use strategy is most desirable, if not imperative.

Development of a Vegetation Management Strategy.

The advanced stages of forest succession and the presence of concomitant insect and disease outbreaks, the recognized occurrence of unique, rare, and endangered plant species, the requirement to rehabilitate previously logged forest stands, and the recent introduction of a national Fire Management Directive, all serve to draw attention to the need for an ecologically sound terrestrial and marine vegetation management strategy.

Development of a Wildlife Management Strategy.

In view of the suggestion to develop a vegetation management strategy, it becomes imperative to develop a similar, and fully integrated, strategy for the terrestrial and marine wildlife resources of the national park reserves. The issue of the protection and preservation of the native wildlife species, and the need to address the future role of some or all of the introduced wildlife species, makes the development of this strategy an urgent requirement.

Protection, Visitor Use, and Interpretation of Sensitive Resources.

Utilizing the collective knowledge of the Visitor Services, Interpretive Services, and Natural Resource Conservation personnel of the park reserve, it is important to develop a sound strategy for the protection, visitor use, and interpretation of "sensitive resources", such as natural features and cultural heritage resources with a high visibility and ecological importance.

The World Heritage Site and the Ecological Reserves.

The roles of the inherited World Heritage Site and the various ecological reserves previously recognized by the Province of British Columbia, need clarification, a) in the context of general park management planning, and, b) particularly in the context of resource management planning for the purposes of providing future protection, preservation, and ecologically sound visitor use of those resources.

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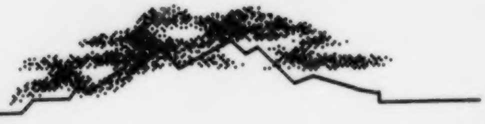

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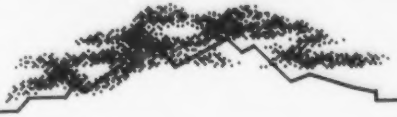

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